The Natural Provenance: Ecoliteracy in Higher Education in Mississippi

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THE NATURAL PROVENANCE:

ECOLITERACY IN HIGHER EDUCATION IN MISSISSIPPI

by

Sarah Elizabeth Wheeless

Abstract of a Dissertation
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ABSTRACT

THE NATURAL PROVENANCE:
ECOLITERACY IN HIGHER EDUCATION IN MISSISSIPPI

by Sarah Elizabeth Wheeless

May 2010

Researchers have suggested that there is an increasing apathy in the study of natural history both in academic settings and in the scientific community (Schmidly, 2005). Natural history is the cornerstone of ecological literacy. However, most studies of environmental knowledge do not directly address knowledge of local natural history. Instead, they concern knowledge of human environmental issues, environmental concepts, or broad ecological knowledge. Ecoliteracy established the study of natural history as fundamental to environmental knowledge and seeks to determine levels of knowledge of local environments and factors associated with that knowledge (Pilgrim et al., 2007).

This study investigated ecoliteracy in Mississippi to determine knowledge of local flora and fauna of undergraduate and graduate students at the largest universities. Overall ecoliteracy in Mississippi was low at the undergraduate and graduate levels. Students from School A had the highest levels of ecoliteracy. Students majoring in wildlife and fisheries and biology had more advanced knowledge of local flora and fauna than non-biology majors. Students were most knowledgeable of reptiles and amphibians, and least proficient in fish and endangered species. Both number of environmental courses taken and environmental sensitivity were positively correlated with ecoliteracy.
Student knowledge of local flora and fauna was most often influenced by courses completed and experience with education or degree programs including fieldwork and research. Natural history knowledge was deficient at Mississippi universities.

Researchers suggest re-emphasizing university coursework focusing on local natural history.
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TABLE OF CONTENTS

ABSTRACT ........................................................................................................................................ ii

ACKNOWLEDGMENTS ................................................................................................................... iv

LIST OF TABLES ............................................................................................................................... vii

LIST OF ILLUSTRATIONS ............................................................................................................... viii

CHAPTER

I. INTRODUCTION ..........................................................................................................................1
  Statements of Purpose
  Research Questions
  Hypotheses
  Definition of Terms
  Delimitations
  Assumptions
  Justification

II. REVIEW OF RELATED LITERATURE .........................................................................................12
  Responsible Environmental Behavior
  Environmental Literacy and Factors Affecting Literacy
  Ecoliteracy and Knowledge of Place
  Natural History in Higher Education

III. METHODOLOGY .......................................................................................................................28
  Research Design
  Participants
  Instrumentation
  Pilot Study
  Validity and Reliability Results
  Procedures
  Data Analysis

IV. ANALYSIS OF DATA ..................................................................................................................38
  Participants
  Ecoliteracy in Mississippi
V. SUMMARY ..................................................................................................................60

The Role of Ecoliteracy
Ecoliteracy in Mississippi
Ecoliteracy across Academic Fields
Factors Associated with Ecoliteracy
The Importance of Direct Experience with Nature

APPENDIXES ..................................................................................................................73

REFERENCES ..................................................................................................................90
## LIST OF TABLES

1. Facility Levels of Students During the Pilot Study ........................................33
2. Discrimination Levels of Student Scores During the Pilot Study .........................34
3. Participants in Survey of Ecoliteracy across Universities in Mississippi ..........38
4. Mean, Lowest, and Highest scores on Ecoliteracy Test for All Students from School A, School B, School C, and All Universities Combined .........................40
5. Undergraduate Ecoliteracy Scores for Biology and Related Fields Compared with Non-Biology Student Scores .................................................................43
6. Graduate Student Ecoliteracy Scores for Biology and Related Fields Compared with Non-Biology Student Scores .................................................................44
7. Comparison of Mean Number Correct out of 5 for Each Section for Undergraduate and Graduate Students from School A, School B, and School C .50
8. Coefficients Table for Multiple Regression with Undergraduate Students ........56
9. Coefficients Table for Multiple Regression with Graduate Students ..............58
LIST OF ILLUSTRATIONS

Figure

1. Average ecoliteracy test scores across Mississippi universities for undergraduates and graduates .................................................................42

2. Average ecoliteracy test scores, grouped by major, of undergrads and grads .... 46

3. Average ecoliteracy scores for undergraduate students from School A, School B, and School C across majors .................................................................47

4. Average ecoliteracy scores for graduate students from School A, School B, and School C across majors .................................................................48

5. Average ecoliteracy test scores across Mississippi universities for biology undergraduates and biology graduates .................................................................52
CHAPTER I

INTRODUCTION

Living organisms and the outdoors are the natural provenance of biology…if our students never get out where biology really happens, how will they be able to understand the real world and their relation to it? (Wivaag, 1994, p.131)

Despite the growing need for ecological literacy and informed scientists willing to take on the environmental challenges of the 21st century (Oskamp, 2000), it has been suggested that there is an increasing apathy in the study of natural history both in academic settings and in the scientific community in general (Futuyma, 1998; Noss, 1996; Schmidly, 2005). A lack of basic knowledge of nature has contributed to the current destruction of natural habitats and loss of biodiversity (Leather & Quicke, 2009).

In an age when the destruction of biodiversity is the norm, we must educate current and future scientists, as well as the general public, to be knowledgeable of the environment in which they live. Natural history, the scientific study of plants and animals in their natural environments (Herman, 2002), is the cornerstone of ecological literacy. Natural history not only instructs in the knowledge of place, but instills an emotional enthusiasm toward natural phenomena: that in nature “which most justly excites our admiration” (Darwin, 1859, p.7). Why would we expect anyone to want to conserve their environment when they are unfamiliar with the intricacies of the natural world, and when those who we expect to find solutions to the problems are more concerned with indoor pursuits?

A pressing concern of conservation biologists and managers who face accelerated extinction rates and loss of critical habitat is a lack of biologists with fundamental knowledge of organisms and ecosystem relationships which could be detrimental to
efforts to conserve and maintain biodiversity (Dayton, 2003; Krupa, 2000; Wilson, 2000). Only 12% of four-year colleges and universities in the United States require environment-based coursework; the vast majority of undergraduate students do not receive basic instruction in environmental literacy (Kaplowitz & Levine, 2005). Courses concerning the identification and life histories of organisms such as herpetology, mammalogy, and ornithology are rapidly disappearing from colleges and university coursework across the globe (Noss, 1996). Students with comprehensive knowledge of local environments are replaced by student specialists who may only know the species which they studied in their graduate work or that their advisors studied in their professional work (Futuyma, 1998).

What is the ecological literacy level of students entering and exiting colleges and universities? What are the factors associated with levels of environmental knowledge? Ironically, the majority of studies concerning environmental knowledge do not directly address knowledge of natural history and local environments. Instead, they often focus on knowledge of environmental issues or problems related to human concerns, environmental concepts, or broad ecological knowledge (Chipeniuk, 1995; Hungerford & Volk, 1990; Leeming, Dwyer, Porter & Cobern, 1993). Leeming et al. (1993) reviewed outcome research in environmental education and, out of 34 studies published since 1974, few if any, included knowledge of natural history or local environments. A study conducted by Kaplowitz and Levine (2005) included some basic ecological knowledge of local areas and revealed that undergraduate, graduate, and professional students at Michigan State University had higher levels of environmental knowledge than the general public, but reduced knowledge overall, with only 66% receiving a passing grade.
on the survey. Student scores were highest in the College of Medicine and were related to educational attainment. Scores were lowest in the College of Education, an important finding in relation to the ability of future teachers to impart environmental knowledge to their students (Kaplowitz & Levine, 2005).

A more current interpretation of environmental literacy, called ecological literacy or ecoliteracy, was employed by Orr (1992) and established the study of natural history as fundamental to environmental knowledge (Berkes, Colding & Folke, 2000; Pilgrim, Smith & Pretty, 2007). Pilgrim et al. (2007) define ecoliteracy as “a cumulative knowledge base that describes local ecosystem components and their interactions most commonly derived from a pool of accumulated observations” (p. 1742). Studies of ecoliteracy are limited. Research is generally related to primary school children and educators at the primary or secondary level and to the local knowledge of indigenous societies. Studies of primary and secondary school students generally found that students have a low level of knowledge of local plants, birds, and other wildlife. Although knowledge seems to increase with age, it is often gained through television programs rather than educational opportunities or direct contact with nature (Balmford, Clegg, Coulson & Taylor, 2002; Bebbington, 2005; Evans, Dixon & Heslop, 2006; Huxham, Welsh, Berry & Templeton, 2006).

Two studies researched the effects of college student knowledge on attitudes toward the environment. Yore and Boyer (1997) found that college students who were “birdwatchers” had more favorable attitudes toward the environment. Tikka, Kuitunen and Tyns (2000) evaluated factors contributing to the environmental knowledge of college and university students in Finland. The researchers found that biology, forestry,
and history students were most knowledgeable about their environment while pre-service teachers and health care students scored among the lowest. They found that knowledge of the local environment was correlated with both positive attitude toward the environment and nature-related activity.

Although research is scant, the previous studies indicate that students at all levels have an overall lack of knowledge of natural history and the environments in which they live. Fortunately, association with biology and nature activities seems to increase nature knowledge and positively affect environmental attitudes and behaviors. This relationship has been supported by studies of the local knowledge of indigenous groups as well as comparisons of societies who rely on knowledge of nature for their survival with those of westernized society (Berkes et al., 2000; Nyhus, Tilson & Tilson, 2003; Pierotti & Wildcat, 2000; Pilgrim et al., 2007). Pilgrim et al. (2007) found that those societies which utilize local environmental information for their livelihood had direct experience with nature and higher ecoliteracy levels. Ecoliteracy in the UK, where knowledge of nature is not necessary for survival, was positively affected by frequent outdoor excursions, living in rural areas, and knowledge received from parents, colleagues, and hobbies. These studies could contribute to an understanding of our loss of natural history and serve as a model for the future of ecoliteracy education.

Considering the debate regarding the loss of natural history at universities as well as the general belief that ecoliteracy is lacking at all scholarly levels, it is surprising that there are few studies that attempt to determine the level of knowledge of nature of university students and what factors may be associated with student knowledge of natural history. If scientists and educators are going to promote responsible environmental
behaviors in their students and in society as a whole, they must find a common educational cause which would instill a desire in people to connect to local environments. Schools, universities, government agencies, and research foundations must review current methodology and agree upon an approach of holistic inclusion of natural history at all levels (Greene, 2005; Herman, 2002; Wilcove & Eisner, 2000).

The present study seeks to address these questions and add to the literature on ecoliteracy and its prevalence in universities. It is an exploration of undergraduate and graduate students at universities across Mississippi and their knowledge of local flora and fauna and the factors contributing to that knowledge. Hopefully, this study will fuel Mississippi educators to help foster in their students a view of nature as “exciting our admiration” and to encourage them to want to work toward solutions to environmental issues we will face in the near future.

Statements of Purpose

The first purpose of this study was to determine the level of ecoliteracy among undergraduate and graduate students at the three largest universities in Mississippi. The focus was on knowledge of students of biology and of biology-related fields such as Biology Education and Wildlife Management, but also made comparisons with students of other disciplines. Level of ecoliteracy was defined by the student’s ability to answer questions concerning local natural history (Pilgrim et al., 2007). Questions included knowledge of local plants and animals, local habitats, and endangered species.

A second purpose of the study was to compare the ecoliteracy of undergraduate and graduate students among these three universities to determine if there were significant knowledge differences between universities. Ecoliteracy of undergraduate and
graduate students in biology or biology-related fields were compared with other academic fields to determine if there were significant differences in knowledge levels. The researcher compared students with an emphasis in molecular and microbiology with those emphasizing organismal biology to determine any significant differences.

A third purpose of the study was to determine factors associated with the dependent variable, level of ecoliteracy. A multiple regression was conducted to determine the amount of the model that was explained by the predictor variables of age, sex, ethnicity, years lived in Mississippi, education level, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature.

A fourth purpose of the study was to determine the self-reported factors contributing to both the level of ecoliteracy and environmental sensitivity levels of the students.

Research Questions

This study was an attempt to investigate the following questions regarding undergraduate and graduate students separately:

1. What is the level of ecoliteracy of students at the three largest universities in Mississippi?
2. How do the levels of ecoliteracy of students at School A, School B, and School C compare across universities?
3. How do the levels of ecoliteracy of students of biology and biology-related fields compare with non-biology majors?
4. How does ecoliteracy of biology students compare across universities?
5. What is the relationship between the level of ecoliteracy and both the number of environment-based courses taken, and the level of environmental sensitivity?

6. What is the relationship between the criterion variable of level of ecoliteracy and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of biology or environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature?

7. What are factors that students report as influencing their level of ecoliteracy and environmental sensitivity?

Hypotheses

This study was designed to evaluate the following null hypotheses:

H1: There is no significant difference in the level of ecoliteracy among undergraduate students at School A, School B, and School C.

H2: There is no significant difference in the level of ecoliteracy of undergraduate biology and non-biology majors across all universities and at School C.

H3: There is no significant difference in the level of ecoliteracy of undergraduate biology students among School A, School B, and School C.

H4: There is no significant correlation between the level of ecoliteracy and both the number of environment-based coursework and environmental sensitivity level of undergraduate students across all universities.

H5: There is no significant relationship between the criterion variable of level of ecoliteracy of undergraduate students and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of biology or environment-
related courses taken, area of residence, environmental sensitivity level, and time spent in nature.

H6: There is no significant difference in the level of ecoliteracy among graduate students at School A, School B, and School C.

H7: There is no significant difference in the level of ecoliteracy of graduate biology and non-biology majors across all universities and at School C.

H8: There is no significant difference in the level of ecoliteracy of graduate biology students among School A, School B, and School C.

H9: There is no significant correlation between the level of ecoliteracy and both the number of environment-based coursework and environmental sensitivity level of graduate students across all universities.

H10: There is no significant relationship between the criterion variable of level of ecoliteracy of graduate students and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of biology or environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature.
Definition of Terms

The following is a list of terms and their meanings with reference to this study:

**Dependent variable**- The variable of level of ecoliteracy as measured by the instrument “Knowledge of Local Flora and Fauna” which was constructed by the researcher.

**Ecoliteracy or Ecological Literacy**- Pilgrim et al. (2007) define ecoliteracy as “a cumulative knowledge base that describes local ecosystem components and their interactions most commonly derived from a pool of accumulated observations” (p. 1742). In this study, ecoliteracy is often used interchangeably with “Natural History.”

**Education level**- The highest college or university degree earned or the highest level obtained or year completed at that point.

**Environmental Sensitivity**- Empathy toward nature or the environment in general (Chawla, 1998).

**Independent variable**- The variables of age, sex, ethnicity, years lived in Mississippi, school attended, academic major, academic emphasis, education level, number of environment-related courses taken, current town size, childhood town size, environmental sensitivity level, time spent in nature, and hobbies.

**Level of Ecoliteracy (LE)**- The participant’s score on the constructed instrument “Knowledge of Local Flora and Fauna.” LE serves as the dependent variable.

**Natural History**- The scientific study of plants and animals in their natural environments (Herman, 2002).
Delimitations

1. The measure of ecoliteracy was limited to the flora and fauna of Mississippi and may be biased toward south Mississippi as it was created and validated by biologists from south Mississippi.

2. This study was limited to students in universities in Mississippi.

3. Due to the scale of this study, it did not include other measures of ecoliteracy, such as knowledge of land and resource management systems and the social institutions and ethics of indigenous people, as mentioned in Pilgrim (2007).

4. All variables not mentioned in this study may be considered beyond the scope of the study.

Assumptions

This study attempted to determine the level of ecoliteracy in undergraduate and graduate students at universities across Mississippi. It was assumed that the participants in the study provided accurate and honest remarks concerning their ecoliteracy knowledge.

Justification

Despite the concern of some biologists and conservationists that the study of natural history is out of favor with universities and other government agencies, there is a serious gap in the scientific and educational literature suggesting that this is the case. The growing interest in ecoliteracy is important to the field of environmental education. It provides a means and justification for the inclusion of knowledge of place and natural history in the science curriculum at all educational levels. The current study has the goal of promoting research in ecoliteracy with the hope of adding to and enhancing the
research perspective. This study will provide specific data as to whether or not there is a lack of natural history knowledge in higher education in Mississippi. Future studies could be conducted in other states to see how they compare with the ecoliteracy in Mississippi and to determine the factors contributing to that literacy.

We desperately need scientists whose life’s work is focused on healing and conserving the earth. We are beyond the point of discussion and action must be taken. It is disheartening to think that the “naturalists are dying off.” Naturalists are often the scientists with a passion for the Earth that is contagious and who spend their lives learning from and helping to preserve our natural resources (Noss, 1996; Wilcove & Eisner, 2000). What measures must educators and administrators take to ensure that we have students who will dedicate themselves to this field? The present study is an attempt to determine the level of ecoliteracy of students in Mississippi universities and will suggest measures that can be taken within universities to ensure that all students and future educators are knowledgeable about the environments in which they live and love.
CHAPTER II

REVIEW OF RELATED LITERATURE

Sustainability: A buzzword on the lips of most conservationists which should be on the minds of all environmentally-friendly scientists. There is a pressing need for humans to change the way they utilize the Earth’s resources so that we and other species can coexist in the future. Oskamp (2000) states, “The most serious long-term threat facing the world is that human actions are producing irreversible, harmful changes to the environmental conditions that support life on Earth. If this problem is not overcome, there may be no viable world for our descendants to inhabit” (p.373). The threats can no longer be ignored, the warming of our planet due to carbon dioxide increases, the substantial loss of biodiversity and acceptable habitats for species, overexploitation of food resources, acid rain, toxic pollutants in the air and our drinking water, and high levels of toxins in human systems as a result of toxin intake (Dayton, 2003; Orr, 1996; Oskamp, 2000). These problems cannot be solved by scientists alone; it will take an unprecedented call to action of all citizens of the Earth.

Who is responsible for providing experience with and understanding of the natural world which is rapidly being depleted? This has been debated in environmental literature since the inception of environmental education. The goals of environmental education are similar to those of all education, to shape human behavior and to create knowledgeable and literate citizens. Issues in the environment ultimately affect all people on Earth. Therefore, the overarching purpose of environmental education is to promote responsible environmental behavior (REB) in citizens of the world (Heimlich, 2002; Wilke, 1993). Objectives for world-wide environmental education were defined by the
1977 Tbilisi Intergovernmental Conference on Environmental Education held by the United Nations Education, Scientific, and Cultural Organization (UNESCO) in Tbilisi, Georgia, in the former USSR. These objectives included fostering an awareness of and sensitivity to the environment and its problems, creating positive attitudes toward the environment, teaching skills to identify and solve environmental issues, and providing individuals with opportunities to be active participants in the resolution of environmental problems and issues (UNESCO, 1978). Environmental Education in the last 40 years has been largely a debate about how best to foster these goals and to create responsible environmental citizens who can take on the environmental issues of the 21st century (Hungerford & Volk, 1990; Knapp, 2000).

Responsible Environmental Behavior

In order to foster REB we must determine the underlying reasons people choose to act responsibly. Traditionally, environmental educators held that the more knowledge one had of the environment and problems therein, the more responsible he or she would be (Hungerford & Volk, 1990). If people knew there were problems in the area in which they live, then they would want to become more aware of these issues and act to change them. As they became more knowledgeable, their attitudes toward nature would improve, leading to more responsible behavior (Hines, Hungerford & Tomera, 1986; Wilke, 1993). Although many studies have been conducted, previous research has not validated this direct, linear association between knowledge and REB (Hungerford & Volk, 1990). Instead, what has emerged from the literature is a layered model of predictors of behavior which includes more than knowledge, awareness, and attitudes; it includes empathy toward the environment, early-life experiences, time spent outdoors, and “significant life
experiences” (Chawla, 2001; Corcoran, 1999; Cottrell, 1997; Ewert, Place & Sibthorp, 2005; Hines et al., 1986; Hungerford and Volk, 1990; Palmberg & Kuru, 2000; Palmer & Suggate, 1996).

From the models of REB came the concept of “entry-level variables” which are considered to be prerequisites to REB (Hungerford & Volk, 1990, p.10). One of the most important of these variables is environmental sensitivity (ES) which is an aspect of awareness of the environment. It is loosely defined as empathy for nature or the environment in which one lives (Chawla, 1998). Studies have indicated that one of the main factors contributing to environmental sensitivity is direct experience in the outdoors at a young age. Those people who were rated as having high environmental sensitivity often had long-term experiences, such as hunting, fishing, camping, or exploring, in familiar natural areas (Chawla, 1998; Hungerford & Volk, 1990; Kals, Schumacher, & Montada, 1999; Wilke, 1993). Research has shown that a high-level of ES is often found in people who have professions promoting or contributing to responsible environmental behavior such as environmental educators or conservation officials (Chawla, 1998).

Knowledge of ecology is considered an entry-level variable, although secondary to environmental sensitivity, and a prerequisite to promoting responsible environmental behavior. Hungerford and Volk (1990) maintain that ecological knowledge is needed to make sound environmental decisions. However, results of studies on the relationship of knowledge and positive environmental behavior have been controversial (Bogner, 1998). Dreyfus (1995) suggested that biological knowledge is a prerequisite in developing positive environmental values and attitudes. A study conducted by Arcury (1990) illuminated a consistent and positive relationship between environmental knowledge and
environmental attitudes. Similarly, Bogner (1998) found a positive relationship between long-term knowledge gain and student attitude toward nature and conservation as a result of experience with short-term outdoor ecology education. Knowledge of the environment is an important concept in the fostering of environmentally literate citizenry for how can we love that which we do not know?

**Environmental Literacy and Factors Affecting Literacy**

Despite strong efforts toward the inclusion of environmental education in schools, there is a growing concern that children are becoming even more disconnected and estranged from the natural world. Roaming in the woods behind one’s house and exploration and investigation of natural phenomenon have been eclipsed by sterile playground areas with limited access to free play or indoor play with video games, television, and computers (Louv, 2005; Vwaag, 1994). Students in grades K-12 spend approximately 8 hours a day, 185 days a year in school, and time is mostly spent focusing on test scores and teacher accountability. Recent research has shown that children spend less time outdoors than their parents did (Clements, 2004) and have less free time and spend more of their time on structured activities (Hofferth & Sandberg, 2001). Turner, Nakamura, and Dinetti (2004) found that people in urban environments experience a low level of biodiversity and therefore, children playing in these environments may lose the opportunity to develop an appreciation for or knowledge of nature.

Although typical high school students may be aware of environmental issues and have discussed climate change and the destruction of rain forests, they are often uneducated in the fundamental issues of their local environments and are almost unaware of the natural resources around them (Weilbacher, 2009). Studies have shown that high
school students have very low levels of environmental knowledge (Blum, 1987; Gambro & Switzky, 1996). Several studies have shown that although high-school students may be able to recognize basic facts regarding environmental issues, they are unable to apply that knowledge to local settings or to suggest possible solutions to the problems (Brody, Chipman & Marion, 1988; Gambro & Switzky, 1996). Similar studies suggest that public knowledge of the environment and environmental issues is rudimentary (Arcury, 1990).

Studies of environmental knowledge have consistently not included knowledge of the local environment but have concerned knowledge of environmental issues or problems related to human concerns, environmental concepts, or broad ecological knowledge (Chipeniuk, 1995; Hungerford & Volk, 1990; Leeming, Dwyer, Porter & Cobern, 1993). Leeming et al. (1993) reviewed outcome research in environmental education and out of 34 studies published since 1974, few if any included knowledge of natural history or local environments. These studies often focus on issues such as environmental pollution, littering, waste treatment, oil spills, and deforestation, and only occasionally considered knowledge of local environments. However, this knowledge is usually on a broad ecological scale such as large watersheds or similar ecosystems and involves questions about human environmental impacts in those areas (Chipeniuk, 1995; Kaplowitz & Levine, 2005; Tikka et al., 2000). Therefore, to interpret the findings of many of the previous studies an explanation of the researchers’ definition of “environmental knowledge” is needed.

Ecoliteracy and Knowledge of Place

What good is a broad knowledge of environmental problems with no connection to the specific land on which they are occurring? In 1992, Orr transformed environmental
literacy into ecological literacy and provided a new conceptual framework. He stated that ecological literacy constitutes “knowing, caring, and practical competence” (Orr, 1992, p.92). Orr suggested that one must first know how his or her natural world works in order to understand how to protect and preserve that world (Cutter-Mackenzie & Smith, 2003). He states, “If literacy is driven by the search for knowledge, ecological literacy is driven by the sense of wonder, the sheer delight in being alive in a beautiful, mysterious, bountiful world” (Orr, 1992, p.86). This “sense of wonder” is akin to the concept of E.O. Wilson’s “biophilia”, the biological need of all humans to connect to nature (Wilson, 1983). To Orr (1992), knowledge of “the facts of life and of the threats to it will not save us in the absence of the feeling of kinship with life of the sort that cannot entirely be put into words” (p.87).

From Orr’s perspective came revitalization in the study of ecological literacy. The study of Traditional Ecological Knowledge (TEK), the knowledge of place held by indigenous people of North America and other continents, was gaining emphasis in the ecological literature and was catching the eye of resource managers and conservationists (Berkes et al., 2000; Nyhus et al., 2003; Pierotti & Wildcat, 2000). Studies of TEK started with general ethno-biology, identification and classification of local species, and expanded into the knowledge of ecological processes and how they relate to the inhabitants of that area (Berkes et al., 2000). Societies that have a long history of interaction with their place and a need for close connection with nature for their survival have a strong knowledge of local environments, including flora and fauna. Therefore, indigenous people may be able to contribute to the wildlife assessments and conservation
measures needed where they live (Berkes et al., 2000; Evans, Gebbels & Stockill, 2008; Nyhus et al., 2003).

Ecoliteracy is currently defined as “a cumulative knowledge base that describes local ecosystem components and their interactions most commonly derived from a pool of accumulated observations” (Pilgrim et al., 2007, p.1742). Pilgrim et al. (2007) described four levels of ecological knowledge: 1) the names of the living and physical components of ecosystems (e.g. plants and animals; soils, water, weather); 2) the functions and uses of each component; 3) the land and resource management systems and the social institutions that govern them; and 4) the worldviews and cosmologies that guide the ethics of people in the system. Studies of ecoliteracy often address one or more aspects of the previous levels.

Current studies in ecoliteracy have extended TEK and applied it to and compared it with the ecological knowledge of western societies. A study by Pilgrim et al. (2007) assessed resource-dependent communities in India as compared with that of non-resource dependent communities in the United Kingdom to determine the factors associated with ecoliteracy. The researchers investigated the first two levels of ecoliteracy: the knowledge of local species and their function in the ecosystem. Respondents were shown a series of species flashcards, specific to the region in which they lived, displaying pictures of local wild flora and fauna. Participants were asked to name the species on the flashcard and to provide any information concerning uses of that species. They found that increased time spent in nature resulted in increased ecoliteracy. In the United Kingdom, a non-resource dependent society where knowledge of the environment is not directly necessary for survival, the most important factors positively affecting ecoliteracy were
the frequency of visits to the “countryside”, living in rural areas as an adult, and growing up in rural areas. Respondents with the highest ecoliteracy levels acquired knowledge from parents or relatives, environment-based occupations, and hobbies. Those who gained knowledge from sources such as television and schooling were not as adept at identifying local species. At the resource-dependent study sites, ecoliteracy significantly declined with increase in wealth. Participants with lower incomes were more likely to utilize resources from their environment and therefore have a broader ecological knowledge. Likewise, children of wealthier families who attended school spent less time in the outdoors resulting in less familiarity with local environments. Men had higher ecoliteracy levels than women. In India, area of residence and residence during childhood had no effect on knowledge levels (Pilgrim et al., 2007).

Other studies utilized the concept of ecoliteracy in the investigation of environmental knowledge. Balmford et al. (2002) developed flashcards consisting of 10 common British species, including two each of plants, invertebrates, mammals, and birds, and 10 characters from the Pokémon card game. The researchers found that children ages 4-11 were able to identify fewer than 50% of common wildlife but were able to identify 80% of Pokémon “species.” These findings suggest that although children have a great capacity to learn to recognize creatures that they are in contact with, those are often not local species.

Similar results were gathered from a study of A-level biology students and their teachers in the United Kingdom (Bebbington, 2005). Students were given illustrations of common wildflowers and were asked to identify the plants that they knew. Eighty-six percent of the students could name three or fewer plants while 41% could only name one
or none. Of their instructors, 65% could name five or more flowers (Bebbington, 2005). A third study conducted by Huxham, Welsh, Berry, and Templeton (2006) examined the wildlife knowledge of children ages 4-12 by using illustrated flashcards containing both local and exotic species. The cards consisted of 20 arthropods, 20 birds, and 28 mammals, and each indigenous species was paired with a similar exotic species. Children were asked to identify the animal and list what it eats and where it lives. The researchers found that knowledge increased with age and gender. Up to 60% of the animals were identified by ages 11-12, and boys performed better than girls. Students had a greater knowledge of mammals than of birds or arthropods, and all students had a greater knowledge of indigenous versus exotic species (Huxham et al., 2006). Another study conducted in the United Kingdom found, similarly, that students’ ability to name common bird species was poor (Evans et al., 2006). Participants were shown color illustrations of 18 common bird species and were asked to write down the name of the birds. Children surveyed could name four common land birds and two shore birds, and scores did not increase with age. However, student knowledge of bird species improved after surveying birds as part of an educational lesson (Evans et al., 2006). Chipeniuk (1995) studied children’s foraging behavior, the collection and investigation of natural items in the environment, to determine the effect on knowledge of the local environment. The researchers found that a broad foraging effort resulted in a better sense of biodiversity. A study conducted by the Lower Merion Conservancy in Pennsylvania investigated the knowledge of birds of high school students. The students were asked to name one bird they could identify by song and none of the students could do so (Weilbacher, 2009).
Few, if any, studies have been conducted on ecoliteracy in higher education. Studies were conducted on undergraduate and graduate knowledge of environmental issues and broad ecological concepts, but not of knowledge of local flora and fauna. Tikka et al. (2000) investigated the effects of educational background on students’ attitudes, activity level, and knowledge concerning the environment. They found that knowledge of the environment was correlated with both positive attitude toward the environment and nature- or environment-related activity. Biology, forestry, and history students had the highest levels of knowledge, while students of teacher training programs and those in the health care field had the lowest (Tikka et al., 2000). A study of the level of environmental knowledge of undergraduate and graduate students was conducted at Michigan State University (Kaplowitz & Levine, 2005). Although students scored higher on an assessment of environmental knowledge than the general public, they had low environmental knowledge. Unlike Tikka et al. (2000), the researchers found that the College of Medicine had the highest environmental knowledge, scoring higher than Agriculture and Natural Resources and Natural Science. Knowledge increased with increased educational level (Kaplowitz & Levine, 2005). Yore and Boyer (1997) found that college students who were self-identified “birdwatchers” had more favorable attitudes toward the environment. It should be noted, however, that these were not measures of ecoliteracy as previously defined.

Natural History in Higher Education

In the mid 1990’s, colleges and universities were challenged to increase their role in creating environmentally literate citizens. The United Nations Earth Summit, held in 1992, directly addressed the role of universities in attempting to analyze and find
solutions to environmental issues (Wilke, 1995). The Council of State Government suggested state legislation that would require universities and colleges to implement programs that encouraged environmental literacy, including an environmental studies course for all graduates (Wilke, 1995). Ten years later, it was reported that only 12% of four-year colleges and universities in the United States require environment-based coursework; the vast majority of undergraduate students do not receive basic instruction in environmental literacy (Kaplowitz & Levine, 2005).

Orr (1996) suggests that colleges and universities have been slow to respond to the impending environmental crisis. This may be a result of the compartmentalization of higher education. Curriculum and research were divided into disciplines, sub-disciplines, and departments, each with their own agenda. The system was not devised to handle the holistic nature environmental problems. For Orr, “all education is environmental education” (1996, p.8) and educators must refrain from teaching students that they are separated from or outside of natural systems.

In higher education, ecoliteracy and those who are ecoliterate could be described as the natural historians and naturalists. Returning to the definition, ecoliteracy is a “cumulative knowledge base that describes local ecosystem components and their interactions” (Pilgrim et al., 2007, p.1742) and describes both the names of the living and physical components of ecosystems and their functions and uses. Herman (2002) stated that natural history is the scientific study of plants and animals in their natural environments, and is concerned with life histories, distributions, abundances, and inter-relationships, from the level of the individual to the ecosystem. Whereas Farber (2000) claimed that the heart of natural history is the quest to find order in nature. Fleischner and
Weisberg (1992) expounded that natural history answers questions such as “What is this? Where am I?, and then follows deeper into questions that connect all beings: Who are you? Who am I? How do we all fit together in this world?” (p.36).

Herman (2000) emphasized that there is an additional aesthetic component of natural history, often exuded by the naturalist. Naturalists are most specifically those who study nature, but include those with a kinship to nature fostered by a life-long compassion for nature and desire to know the local environment from deep, personal experience. Futuyma (1998) stated,

I think of a scientific naturalist as a person with a deep and broad familiarity with one or more groups of organisms or ecological communities, who can draw on her knowledge of systematic, distribution, life histories, behavior, and perhaps physiology and morphology to inspire ideas, to evaluate hypotheses, to intelligently design research with an awareness of organisms’ special peculiarities. Even more, perhaps, he is the person who is inexhaustibly fascinated by biological diversity, and who does not view organisms merely as models, or vehicles for theory, but, rather, as the raison d’être for biological investigation, as the Ding an sich, the thing in itself, that excites our admiration and our desire for knowledge, understanding, and preservation. (p.2)

One of the greatest naturalists of all times, Charles Darwin, exemplified this definition and lived in a time when naturalists such as Louis Agassiz and Thomas Huxley set the stage for the coming century of naturalists such as Robert MacArthur, Ernst Mayr, and E. O. Wilson (Krupa, 2000).
Many biologists, conservationists, and educators have suggested that there is a decreasing interest in the study of natural history at academic institutions and in the scientific community in general (Futuyma, 1998; Grant, 2000; Noss, 1996; Schmidly, 2005; Wilcove & Eisner, 2000; but see Arnold, 2003). Noss (1996) claimed that “the naturalists are dying off and have few heirs” (p.1). Courses typically taught by the naturalists, such as those concerning local flora and fauna or that deal with specific taxonomic groups such as vertebrate and invertebrate biology, plant biology, and mycology, are declining (Dayton, 2003; Futuyma, 1998; Noss, 1996; Schmidly, 2005). Natural history courses often include a “field” component, allowing the students and professors time to connect with their natural surroundings. The loss of coursework leads to the loss of field trips and direct experience with nature. Administrators are no longer willing to pay for travel in vans or for mileage fees (Krupa, 2000). Introductory biology courses have reduced or eliminated outdoor field trips or field experiments (Wilcove & Eisner, 2000). Students enrolled in introductory courses are often choosing or searching for a career path and the elimination of natural history is not providing them an opportunity to choose that as a field of study (Krupa, 2000).

Wilcove and Eisner (2000) mention that knowledge of natural history is no longer needed to enter graduate programs in ecology or other branches of biology. Futuyma (1998) suggests that students with comprehensive knowledge of local environments are replaced by student specialists who may only know the species which they studied for their graduate work, or that their advisor studied for his or her professional work. He gave a questionnaire to graduate and postdoctoral students at the 1993 annual meeting of the American Society of Naturalists, the Society for the Study of Evolution, and the
Society of Systematic Biologists and gained 136 returned surveys. The researcher asked participants about their source of knowledge of systematics or of higher taxa and found that 71% ranked “self-training” as the highest, with a “mentor” as the second highest factor affecting their knowledge. Only 18% mentioned undergraduate or graduate coursework as important to their current knowledge, a finding that may reflect the decline of and disinterest in natural history courses.

Has natural history, a discipline so fundamental to all aspects of biology, fallen out of favor of the universities that rely on it? Schmidly (2005) contributes some of the decline of natural history to the shift from outdoor to indoor studies. Certain approaches have become popular while others, such as natural history, have been neglected. Long-term field studies have been abandoned because they were no longer funded and were more time-consuming than needed for dissertation or tenure research. Universities disposed of research collections while departments of zoology and entomology have been replaced with departments of biochemistry and evolutionary biology (Schmidly, 2005). Cheesman, French, Cheesman, Swails, and Thomas (2007) studied the change in undergraduate biology requirements since 1990 and found that courses in the molecular areas of biology are more likely to be required than ecology or plant and animal classification. Wilcove and Eisner (2000) said,

The deinstitutionalization of natural history looms as one of the biggest scientific mistakes of our time, perpetrated by the very scientists and institutions that depend upon natural history for their well-being. What’s at stake is the continued vibrancy of ecology, of animal behavior, and botany, of much of molecular biology, and of even medicine and biotechnology (p.B24).
Loss of biodiversity and critical habitat are two of the most pressing environmental issues of the current century. Greene (2005) states, “I am worried primarily about our ignorance of the ecology and behavior of most extant organisms, a knowledge gap that is so large that, for most species, even in the best-studied regions on Earth, we cannot specify the most basic aspects of their biology” (p.25). There is an urgent need to understand the vast decline of species on Earth and how these species interact with one another. Of the species which scientists have named, less than 1% has been studied beyond habitat preference and basic anatomy (Wilson, 2000). Dayton states, “It seems unlikely that meaningful conservation and restoration can be accomplished unless we recover the tradition of supporting research in and the teaching of natural history” (2003, p.1). Natural History is “the touchstone for synthesis (biological significance), analysis (biological mechanism), developing incisive field experiments, and creating theories and models close enough to reality to be taken seriously” (Bartholomew, 1986, p.327). In order to solve our environmental problems, we must train scientists who are able to understand organisms and their environments, and natural history is the principle source of information concerning organisms living under natural conditions (Bartholomew, 1986; McGlynn, 2008).

What can be done to return natural history to its proper place in the university establishment? Wilson (2000) states,

For in order to care deeply about something important it is first necessary to know about it. So let us resume old-fashioned expeditions at a quickened pace, solicit money for permanent field stations, and expand the support of young scientists—call them ‘naturalists’ with pride—who by inclination and the impress of early
experience commit themselves to deep knowledge of particular groups of organisms. (p.2)

Krupa (2000) suggests including outdoor laboratory exercises on campus, taking classes to biological stations, reinstating day and weekend field trips, and instilling in students the naturalist philosophy of discovery, awareness, and spontaneity. On a larger scale, Schmidly (2005) recommends hiring faculty with an “abiding affection” for natural history, while Leather and Quicke (2009) recommend recruiting young naturalists to university posts instead of replacing them with biologist of more narrow disciplines. Additional importance should be placed on providing information on job opportunities with organizations such as The Nature Conservancy and with state and federal agencies (Schmidly, 2005). Noss (1996) states,

How can the biologist who lacks a long-term emotional investment in wild places be trusted to exercise sound judgment in making recommendations for conservation?...Nothing will destroy the science and mission of conservation biology faster than a generation or two of biologists raised on dead facts and technology and lacking direct, personal experience with nature. (p.2)

It is time for university departments, professional societies, government and private agencies, and citizens of the world to join together and support the second coming of natural history.
CHAPTER III

METHODOLOGY

The purpose of this study was to determine the level of ecoliteracy among undergraduate and graduate students at the three largest universities in Mississippi and to determine factors affecting the level of ecoliteracy such as age, sex, ethnicity, years lived in Mississippi, academic major, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature. Chapter III presents a description of the research design, participants, instrumentation, procedures, and treatment of data.

Research Design

The research questions addressed in this study concerned undergraduate and graduate students separately and were:

1. What is the level of ecoliteracy of students at the three largest universities in Mississippi?
2. How do the levels of ecoliteracy of students at School A, School B, and School C compare across universities?
3. How do the levels of ecoliteracy of students of biology and biology-related fields compare with non-biology majors?
4. How does ecoliteracy of biology students compare across universities?
5. What is the relationship between the level of ecoliteracy and both the number of environment-based courses taken, and the level of environmental sensitivity?
6. What is the relationship between the criterion variable of level of ecoliteracy and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of biology or environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature?

7. What are factors that students report as influencing their level of ecoliteracy and environmental sensitivity?

In order to answer these questions, the researcher used the following dependent and independent variables. The dependent variable collected was the levels of ecoliteracy of undergraduate students and graduate students at three universities in Mississippi. The independent variables collected were age, sex, ethnicity, years lived in Mississippi, academic major, academic emphasis, education level, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature.

Participants

The participants of this study consisted of undergraduate and graduate students, at universities in Mississippi. Universities included School A, having a stronger agricultural emphasis than the other two schools, School B, having a general education program with strengths in the medical field, and School C, with a general education curriculum. A combination of physical questionnaires and email questionnaires were given to students in courses in the fields of Biology (BIO), Environmental Science, Forestry, Natural Resources, and Wildlife and Fisheries (WaF). Students from departments of English (Other) were surveyed for comparisons.
Instrumentation

The instrument used to collect data on the level of ecoliteracy was the knowledge test “Knowledge of Local Flora and Fauna” (KWL) and was created for this project by the researcher. The test consisted of 35 multiple choice questions and had 7 sections with 5 questions in each section (Appendix A). Sections included birds, mammals, plants, reptiles and amphibians, fishes, invertebrates, and endangered species. In each section, the questions increased in difficulty from 1 to 5, 1 being a question that someone with limited knowledge of the environment should be able to correctly answer and 5 being a question that only a graduate or professional in the subject would be able to answer. The knowledge test was developed with the help of a biology graduate student and questions were derived from information found in field guides and textbooks concerning local and regional flora and fauna (Borror & White, 1970; Burt & Grossenheider, 1980; Conant & Collins, 1998; Mississippi Museum of Natural Science, 2001; Page & Burr, 1991). The test was similar to other measures of ecoliteracy (Balmford et al., 2002; Bebbington, 2005; Chipeniuk, 1995; Evans et al., 2006; Huxham et al., 2006; Pilgrim et al., 2007).

The same paper-based test was created in an internet-based format using the survey program “Survey Monkey” (Finley, 2009).

Pilot Study

Since the KWL was constructed by the researcher, a pilot study was conducted during the fall of 2007 to test the validity and reliability of the instrument. To validate the test for content and for biological accuracy, it was given to three biology professors, one expert on plants, one expert on reptiles and amphibians and endangered species, and one
expert on fishes, invertebrates, and endangered species. The instrument was then modified to correct the problems discerned by the experts.

Other validation techniques used included an item analysis using facility and discrimination measurements, both conducted in Microsoft Excel. Questionnaires with a cover letter explaining the project were given, during class, to 95 undergraduate and graduate students majoring in biology, elementary education, biology education, science education, and other non-biology majors at School C in the fall of 2007. The participants ranged in age from 18-56 with a mean of 25. The sample consisted of 47 biology majors and 48 non-biology majors. Of the biology majors, 11 were lower-level undergraduates (freshmen and sophomores), 29 were upper-level undergraduates (juniors and seniors), and 7 were graduate students. Of the non-biology majors, 17 were lower-level undergraduates, 24 were upper-level undergraduates, and 7 were graduates. Five undergraduate biology education students and 7 graduate biology education students were surveyed. Twenty-two Elementary Education majors participated.

Facility was defined as the total number of correct answers for each item divided by the total number of people who had taken the test. I expected a decreasing level of facility from questions 1 to 5 in each section, as 4 and 5 should be more difficult than 1 and 2. Discrimination was determined by dividing the total test scores into two groups, the first being those who scored the highest and the second being those who scored the lowest. The formula used was the total number of correct answers for each item from the high-scoring group minus the total number of correct answers for each item from the low-scoring group divided by the number of participants in the larger of the two groups (Kubiszyn & Borich, 2000). I expected to see an opposite distribution of values for the
discrimination compared to the facility. I expected the discrimination values for questions 1 and 2 to be low and values to increase for questions 3 through 5. A test-retest method was utilized with students in a biology education course and a science education course at School C during the spring of 2008. Biserial and Pearson correlations were used to test total pre-post correlation and individual item correlation to determine a measure of reliability.

Validity and Reliability Results

Of the three Biology professors who looked at the knowledge test for content validity and biological accuracy, only one had comments other than just superficial changes to wording or to changing the difficulty level of a question. That professor indicated that there were two questions, one question in plants and one in fishes, which had more than one correct answer or were improperly worded for accuracy. A comparison with the facility and discrimination indices (see Tables 1 and 2) for those two questions indicated that the plants question may have been too hard as the facility value was only 0.26 which should be lower for a level 3 question. For the fish question, the discrimination was slightly higher than expected, indicating that there may not have been an issue with the two choices, at least for the more knowledgeable students. Both questions were adjusted for clarity and accuracy.

Results of the facility and discrimination indices showed that for the most part the instrument is valid. Although there were some questions that needed to be switched in a section due to the difficulty, with the exception of the plants section the facility numbers were close to my predictions (Table 1). Question number 4 in the plants section had a 0.09 on facility, indicating that it may have been too hard or needed adjustment.
Likewise, questions 2 in both fishes and invertebrates had facility scores of 0.25 and 0.23 indicating that those questions were either too hard or needed to be changed. All of these questions were reordered to adjust for difficulty.

More information concerning specific questions was illuminated when looking at both the facility and the discrimination (Tables 1 and 2). For example, question number 5 in mammals had a high facility, 0.46, indicating that it may have been too easy for a level five question, but when combined with the discrimination value of 0.00 it became apparent that both students scoring high on the test and students scoring low on the test were correctly answering that question. Similarly, questions 4 in both the birds and mammals section had somewhat high facility scores, 0.34 and 0.46, but had negative discrimination scores, indicating that students answering those two questions correctly were not the higher-scoring students. These items were not changed as it was determined that the questions may have been out of the knowledge range of the pilot subjects.

Table 1

Facility Levels of Student Scores During the Pilot Study

<table>
<thead>
<tr>
<th></th>
<th>BIRD</th>
<th>MAM.</th>
<th>PLANT</th>
<th>R&amp;A</th>
<th>FISH</th>
<th>INV.</th>
<th>E.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.71</td>
<td>0.87</td>
<td>0.86</td>
<td>0.74</td>
<td>0.67</td>
<td>0.69</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>0.42</td>
<td>0.32</td>
<td>0.64</td>
<td>0.68</td>
<td>0.25</td>
<td>0.42</td>
<td>0.23</td>
</tr>
<tr>
<td>3</td>
<td>0.52</td>
<td>0.52</td>
<td>0.26</td>
<td>0.57</td>
<td>0.31</td>
<td>0.55</td>
<td>0.51</td>
</tr>
<tr>
<td>4</td>
<td>0.34</td>
<td>0.46</td>
<td>0.09</td>
<td>0.38</td>
<td>0.38</td>
<td>0.56</td>
<td>0.54</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
<td>0.42</td>
<td>0.20</td>
<td>0.38</td>
<td>0.36</td>
<td>0.42</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*Note. Columns are test sections: Birds, Mammals, Plants, Reptiles and Amphibians, Fish, Invertebrates, and endangered species.*
Table 2

Discrimination Levels of Student Scores During the Pilot Study

<table>
<thead>
<tr>
<th></th>
<th>BIRD</th>
<th>MAM.</th>
<th>PLANT</th>
<th>R&amp;A</th>
<th>FISH</th>
<th>INV.</th>
<th>E.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.15</td>
<td>0.15</td>
<td>0.13</td>
<td>0.17</td>
<td>0.42</td>
<td>0.42</td>
<td>0.17</td>
</tr>
<tr>
<td>2</td>
<td>0.08</td>
<td>0.13</td>
<td>0.19</td>
<td>0.31</td>
<td>0.33</td>
<td>0.38</td>
<td>0.29</td>
</tr>
<tr>
<td>3</td>
<td>0.35</td>
<td>0.40</td>
<td>0.10</td>
<td>0.54</td>
<td>0.23</td>
<td>0.50</td>
<td>0.33</td>
</tr>
<tr>
<td>4</td>
<td>-0.08</td>
<td>-0.08</td>
<td>-0.06</td>
<td>0.46</td>
<td>0.21</td>
<td>0.40</td>
<td>0.48</td>
</tr>
<tr>
<td>5</td>
<td>0.10</td>
<td>0.00</td>
<td>-0.10</td>
<td>0.29</td>
<td>0.17</td>
<td>0.13</td>
<td>0.21</td>
</tr>
</tbody>
</table>

*Note.* Columns are test sections: Birds, Mammals, Plants, Reptiles and Amphibians, Fish, Invertebrates, and endangered species.

Results of the reliability methods indicated a strong test-retest correlation of 0.896 and an individual item correlation varying from 0.03 to 1.0 with an average correlation of 0.575. Overall, the test was highly reliable and valid for the audience, and only minor changes were made.

Procedures

Permission for both the pilot and main studies was obtained from the Human Subjects Protection Review Committee (Appendix B). The KWL instrument was distributed in the fall and spring of 2009-2010. The instruments were either administered to students or they were disseminated by email. A prenotice was emailed to potential participants of the online survey, as recommended by Kaplowitz, Hadlock and Levine (2004). Physical questionnaires contained a cover letter (Appendix A) explaining the project and were given, during classes, to students. Email surveys contained a cover letter explaining the project and were emailed to students during the fall and spring semesters.
of 2009-2010. Emails were sent to professors detailing the nature of the study and how to conduct the email questionnaires.

Self-reported factors affecting knowledge of local flora and fauna and environmental sensitivity were recorded in excel and coded into categories according to the number of times each item was mentioned. Factors were recorded from the overall top 100 scores on the knowledge test.

Data Analysis

A significance level of 0.05 was used to test all hypotheses. Data were entered into Microsoft Excel and were imported into SPSS for analysis. The following statistical procedures were used to test the following hypotheses:

H1: There is no significant difference in the level of ecoliteracy among undergraduate students at School A, School B, and School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H2: There is no significant difference in the level of ecoliteracy of undergraduate biology, wildlife and fisheries, and non-biology majors across all universities and within School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H3: There is no significant difference in the level of ecoliteracy of undergraduate biology students among School A, School B, and School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H4: There is no significant correlation between the level of ecoliteracy and the number of environment-based coursework or environmental sensitivity level of
undergraduate students across all universities. Tested with a “Spearman’s Rho” correlation.

H5: There is no significant relationship between the criterion variable of level of ecoliteracy of undergraduate students and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature. Tested using a multiple linear regression.

H6: There is no significant difference in the level of ecoliteracy among graduate students at School A, School B, and School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H7: There is no significant difference in the level of ecoliteracy of graduate biology, wildlife and fisheries, and non-biology majors across all universities and at School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H8: There is no significant difference in the level of ecoliteracy of graduate biology students among School A, School B, and School C. Tested with a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests.

H4: There is no significant correlation between the level of ecoliteracy and the number of environment-based coursework or environmental sensitivity level of graduate students across all universities. Tested with a “Spearman’s Rho” correlation.

H10: There is no significant relationship between the criterion variable of level of ecoliteracy of graduate students and the composite of predictor variables of age,
sex, ethnicity, years lived in Mississippi, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature. Tested using a multiple linear regression.
CHAPTER IV
ANALYSIS OF DATA

Participants

Five-hundred and thirteen surveys were collected from the three largest universities in Mississippi (see Table 1). School C had the greatest number of participants, 73%, while 19% were students from School A, and 8% were from School B. Undergraduate students were the majority of those sampled, and 63% of the sample consisted of biology students. There was a higher percentage of males than females and a higher percentage of Caucasians than of African Americans or other ethnicities.

Table 3

Participants in Survey of Ecoliteracy across Universities in Mississippi

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Undgs</th>
<th>Grads</th>
<th>Bio</th>
<th>WaF</th>
<th>Other Major</th>
<th>M</th>
<th>F</th>
<th>Cauc</th>
<th>Afr Amer</th>
<th>Other Ethn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sch. A</td>
<td>92</td>
<td>65</td>
<td>27</td>
<td>2</td>
<td>66</td>
<td>24</td>
<td>54</td>
<td>38</td>
<td>82</td>
<td>7</td>
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<tr>
<td></td>
<td>(19)</td>
<td>(16)</td>
<td>(30)</td>
<td>(1)</td>
<td>(99)</td>
<td>(20)</td>
<td>(26)</td>
<td>(14)</td>
<td>(22)</td>
<td>(9)</td>
<td>(8)</td>
</tr>
<tr>
<td>Sch. B</td>
<td>41</td>
<td>25</td>
<td>16</td>
<td>39</td>
<td>1</td>
<td>1</td>
<td>20</td>
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<tr>
<td></td>
<td>(8)</td>
<td>(6)</td>
<td>(18)</td>
<td>(12)</td>
<td>(1)</td>
<td>(1)</td>
<td>(10)</td>
<td>(7)</td>
<td>(9)</td>
<td>(2)</td>
<td>(20)</td>
</tr>
<tr>
<td>Sch. C</td>
<td>358</td>
<td>310</td>
<td>48</td>
<td>266</td>
<td>0</td>
<td>92</td>
<td>132</td>
<td>220</td>
<td>255</td>
<td>74</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(73)</td>
<td>(78)</td>
<td>(52)</td>
<td>(87)</td>
<td>(0)</td>
<td>(79)</td>
<td>(64)</td>
<td>(79)</td>
<td>(69)</td>
<td>(89)</td>
<td>(72)</td>
</tr>
<tr>
<td>Total</td>
<td>513</td>
<td>397</td>
<td>92</td>
<td>307</td>
<td>67</td>
<td>117</td>
<td>206</td>
<td>278</td>
<td>369</td>
<td>83</td>
<td>36</td>
</tr>
</tbody>
</table>

Note. Values in parentheses are percentages. Undgs.=undergraduate students; Grads=graduate students; Bio=biology majors; WaF=wildlife and fisheries majors; Other Major=students from non-biology majors; M=males; F=females; Cauc=Caucasians; Afr Amer=African Americans; Other Ethn=students from ethnicities other than Caucasian and African American.

Other variables included age, area of residence, hours spent outdoors, years lived in Mississippi, number of environment-based courses taken, and environmental sensitivity level. The average age was 23 (SD=4.99) years and the average number of years lived in Mississippi was 16.33 (SD=13.77). One-hundred and eighty students lived
in rural areas, 162 lived in suburban areas, and 147 lived in urban areas. School A students spent more time outdoors, from 5.6 to 8.5 hours versus 2.6 to 5.5 hours for students from School B and School C. Additionally, School A had a higher average number of students living in rural areas. The average number of environment-related courses taken was 2.56 (SD=3.73) overall, with 5.22 (SD=5.2) courses for School A students, 3.76 (SD=3.94) for students from School B, and 1.74 (SD=2.76) for students from School C. The average environmental sensitivity level, on a scale from a lowest score of 1 to a highest score of 10, was 7.22 (SD=2.04) overall, and was 7.48 (SD=1.93) for School A students, 7.41 (SD=2.13) for students from School B, and 7.12 (SD=2.06) for School C students.

Ecoliteracy in Mississippi

**Ecoliteracy of Students at the Three Largest Universities in Mississippi**

Across Mississippi, scores on the test of ecoliteracy were generally low (see Table 2). Undergraduate students scored a mean of 52% on the test (n=397, SD=5.35), while graduate students scored slightly higher at 62% (n=92, SD=6.31). The highest score, out of 35, for undergraduate students was 34, while the highest for graduates was 33. Students from School A had the highest mean scores, with the undergraduates scoring 55% (n=64, SD=7.19) and graduates scoring 81% (n=28, SD=3.61). The undergraduates had a highest score of 34, while the graduates had a highest score of 33. At School B, undergraduates had a mean score of 51% (n=64, SD=3.82), with a highest score of 26. Graduate students had a mean score of 70% (n=16, SD=7.29), with a highest score of 32. Undergraduate students from School C had a mean score of 51% (n=308, SD=4.94) with
a highest score of 31. Graduate students had a mean score of 62% (n=48, SD=5.96), with a highest score of 33.

Table 4

*Mean, Lowest, and Highest Scores on Ecoliteracy Test for All Students from School A, School B, School C, and All Universities Combined*

<table>
<thead>
<tr>
<th>University</th>
<th>Classification</th>
<th>Mean (%)</th>
<th>n</th>
<th>SD</th>
<th>Lowest (out of 35)</th>
<th>Highest (out of 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>Undergrad</td>
<td>19.92 (55)</td>
<td>64</td>
<td>7.188</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Grad</td>
<td>28.46 (81)</td>
<td>28</td>
<td>3.605</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>22.52 (64)</td>
<td>92</td>
<td>7.432</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>School B</td>
<td>Undergrad</td>
<td>17.68 (51)</td>
<td>25</td>
<td>3.816</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Grad</td>
<td>24.62 (70)</td>
<td>16</td>
<td>7.293</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20.39 (58)</td>
<td>41</td>
<td>6.360</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>School C</td>
<td>Undergrad</td>
<td>17.84 (51)</td>
<td>308</td>
<td>4.936</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Grad</td>
<td>21.71 (62)</td>
<td>48</td>
<td>5.961</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>18.37 (52)</td>
<td>356</td>
<td>5.246</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>Undergrad</td>
<td>18.17 (52)</td>
<td>397</td>
<td>5.346</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Grad</td>
<td>24.27 (62)</td>
<td>92</td>
<td>6.314</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19.32 (55)</td>
<td>489</td>
<td>6.027</td>
<td>2</td>
<td>34</td>
</tr>
</tbody>
</table>

Undergraduate students from all schools scored the highest on the section concerning reptiles and amphibians, while scoring lowest on endangered species.

Similarly, graduate students scored highest on the reptiles and amphibians, but scored lowest on the section covering fish. School A undergraduates scored highest on the mammals section and the lowest on the section on invertebrates. Graduate students from School A scored highest on the reptiles and amphibians and lowest on birds. All students
from School B scored highest on the section on reptiles and amphibians and scored lowest on fish. Similarly, all students from School C scored highest on the reptiles and amphibians, but scored lowest on endangered species.

Since the assumptions of normality and equal variances were not met, a non-parametric Kruskal-Wallis test and non-parametric Mann-Whitney tests were conducted to test the following hypotheses:

H1: There is no significant difference in the level of ecoliteracy among undergraduate students at School A, School B and School C.

H6: There is no significant difference in the level of ecoliteracy among graduate students at School A, School B and School C.

The null hypothesis H1 was not rejected as results indicated that there was no significant difference in the level of ecoliteracy among undergraduate students ($X^2=5.68$, df=2, p=0.058). The null hypothesis H6 was rejected because results indicated that there was a significant difference in the level of ecoliteracy among graduate students ($X^2=23.7$, df=2, p<0.001). Results of a Mann-Whitney test indicated that the mean scores for School A graduate students were significantly higher than scores from School B (U=144.0, p=0.049) and were significantly higher than graduate students from School C (U=229.0, p<0.001). Mean scores for School B graduate students were significantly higher than those from School C (U=252.0, p=0.04) (see Figure 1).
Figure 1. Average ecoliteracy test scores across Mississippi universities for undergraduates (blue bars) and graduates (green bars). Numbers in parentheses are sample sizes.

Ecoliteracy of Students of Biology Compared with Non-Biology Fields

Undergraduate scores on the test of ecoliteracy were generally low (see Table 3). Students from wildlife and fisheries (WaF) scored the highest with a mean of 67% correct on the test (n=38, SD=6.12). Biology (BIO) students scored a mean of 52% (n=257, SD=4.71), while non-biology (Other) students scored an average 46% correct. Graduate scores on the test of ecoliteracy were generally low (see Table 4). Students from wildlife and fisheries scored the highest with a mean of 81% on the test (n=49, SD=3.55). Biology students scored a mean of 68% (n=49, SD=6.13), while non-biology students scored an average 49% correct (n=14, SD=4.63).
Table 5

**Undergraduate Ecoliteracy Scores for Biology and Related Fields Compared with Non-Biology Student Scores**

<table>
<thead>
<tr>
<th>University</th>
<th>Major</th>
<th>Mean (%)</th>
<th>n</th>
<th>Std. Dev.</th>
<th>Lowest (out of 35)</th>
<th>Highest (out of 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>BIO</td>
<td>15.00 (43)</td>
<td>2</td>
<td>0.000</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>WAF</td>
<td>23.39 (67)</td>
<td>38</td>
<td>6.118</td>
<td>8</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>14.83 (42)</td>
<td>24</td>
<td>5.677</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19.92 (57)</td>
<td>64</td>
<td>7.188</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>School B</td>
<td>BIO</td>
<td>17.33 (50)</td>
<td>24</td>
<td>3.472</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>26.00 (74)</td>
<td>1</td>
<td>.</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17.68 (51)</td>
<td>25</td>
<td>3.816</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>School C</td>
<td>BIO</td>
<td>18.36 (52)</td>
<td>231</td>
<td>4.827</td>
<td>5</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>16.30 (47)</td>
<td>77</td>
<td>4.966</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17.84 (51)</td>
<td>308</td>
<td>4.936</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>BIO</td>
<td>18.24 (52)</td>
<td>257</td>
<td>4.711</td>
<td>5</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>WAF</td>
<td>23.39 (67)</td>
<td>38</td>
<td>6.118</td>
<td>8</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>16.05 (46)</td>
<td>102</td>
<td>5.223</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>18.17 (52)</td>
<td>397</td>
<td>5.346</td>
<td>2</td>
<td>34</td>
</tr>
</tbody>
</table>
Table 6

Graduate Student Ecoliteracy Scores for Biology and Related Fields Compared with Non-Biology Student Scores

<table>
<thead>
<tr>
<th>University</th>
<th>Major</th>
<th>Mean (%)</th>
<th>n</th>
<th>Std. Dev.</th>
<th>Lowest (out of 35)</th>
<th>Highest (out of 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>WAF</td>
<td>28.46 (81)</td>
<td>28</td>
<td>3.605</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>28.46 (81)</td>
<td>28</td>
<td>3.605</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>School B</td>
<td>BIO</td>
<td>24.47 (70)</td>
<td>15</td>
<td>7.520</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>WAF</td>
<td>27.00 (77)</td>
<td>1</td>
<td></td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24.63 (70)</td>
<td>16</td>
<td>7.293</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>School C</td>
<td>BIO</td>
<td>23.53 (67)</td>
<td>34</td>
<td>5.517</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>17.29 (49)</td>
<td>14</td>
<td>4.631</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>21.71 (62)</td>
<td>48</td>
<td>5.961</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>BIO</td>
<td>23.82 (68)</td>
<td>49</td>
<td>6.133</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>WAF</td>
<td>28.41 (81)</td>
<td>29</td>
<td>3.551</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td>17.29 (49)</td>
<td>14</td>
<td>4.631</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>24.27 (69)</td>
<td>92</td>
<td>6.314</td>
<td>4</td>
<td>33</td>
</tr>
</tbody>
</table>

Since the assumptions of normality and equal variances were not met, a non-parametric Kruskal Wallis test and non-parametric t-tests were conducted to test the following hypotheses:

H2: There is no significant difference in the level of ecoliteracy of undergraduate biology, wildlife and fisheries, and non-biology majors across all universities and within School C.

H7: There is no significant difference in the level of ecoliteracy of graduate biology, wildlife and fisheries, and non-biology majors across all universities and at School C.
The null hypothesis H2 was rejected because results indicated that there was a significant difference in the level of ecoliteracy of undergraduate biology, wildlife and fisheries, and non-biology majors across universities ($X^2=43.868$, df=2, $p<0.001$). Results of a Mann-Whitney test indicated that the mean scores for undergraduate wildlife and fisheries students were significantly higher than those of undergraduate biology students ($U=2342.5$, $p<0.001$) and scores from undergraduate biology students were significantly higher than non-biology students ($U=9950.0$, $p<0.001$) (see Figure 2).

The null hypothesis H7 was rejected because results indicated that there was a significant difference in the level of ecoliteracy of graduate biology, wildlife and fisheries, and non-biology majors across universities ($X^2=31.11$, df=2, $p<0.001$). Results of a Mann-Whitney test indicated that the mean scores for graduate wildlife and fisheries students were significantly higher than those of graduate biology students ($U=372.0$, $p<0.001$) and scores from graduate biology students were significantly higher than non-biology graduate students ($U=124.5$, $p<0.001$) (see Figure 2).
Figure 2. Average ecoliteracy test scores, grouped by major, of undergrads (blue bars) and grads (green bars). Numbers in parentheses are sample sizes.

A non-parametric Mann-Whitney test was used to test the null hypothesis that there was no significant difference in the level of ecoliteracy of undergraduate biology and non-biology students at School C. The null hypothesis was rejected because results indicated that scores from undergraduate biology students were significantly higher than non-biology students (U=6868.0, p=0.003). A non-parametric Mann-Whitney test was used to test the null hypothesis that there was no significant difference in the level of ecoliteracy of graduate biology and non-biology students at School C. The null hypothesis was rejected because results indicated that scores from graduate biology students were significantly higher than non-biology students (U=98.0, p<0.001).
Undergraduate students from wildlife and fisheries at School A had the highest mean scores of 67% (n=38, SD=6.118), with a highest score of 34 (see Figure 3). School A students from other fields scored 42% correct (n=24, SD=5.68), and a highest score of 28 out of 35 (see Table 3). At School B, biology undergraduates had a mean score of 50% (n=24, SD=3.47), with a highest score of 24 out of 35. Undergraduate biology students from School C had a mean score of 52% (n=231, SD=4.83) with a highest score of 31. School C students from other majors scored 47% (n=77, SD=4.97) with a highest of 30 out of 35.

![Figure 3](image.png)

*Figure 3. Average ecoliteracy scores for undergraduate students from School A (maroon bars), School B (blue bars) and School C (gold bars) across majors. Numbers in parentheses are sample sizes.*

Graduate students from wildlife and fisheries at School A had the highest mean scores of 81% (n=28, SD=3.61), with a highest score of 33 (see Figure 4). At School B, biology graduates had a mean score of 70% (n=15, SD=7.52), with a highest score of 32 out of 35. There were no students from non-biology fields from School B. Graduate
biology students from School C had a mean score of 67% (n=34, SD=5.52) with a highest score of 33. School C students from other majors scored 49% (n=14, SD=4.63) (see Table 4).

![Figure 4](image)

*Figure 4.* Average ecoliteracy scores for graduate students from School A (maroon bars), School B (blue bars) and School C (gold bars) across majors. Numbers in parentheses are sample sizes.

Of the undergraduate students from biology and biology-related fields, across all universities scores were highest for the sections concerning reptiles and amphibians and lowest for those concerning endangered species (see Table 5). Undergraduates from School A scored highest on the section concerning mammals and lowest on the endangered species. At School B, undergraduate students scored highest on the reptile and amphibians and lowest on fish. Undergraduate students at School C scored the highest on reptiles and amphibians and lowest on endangered species. Graduate students
from biology and biology-related fields scored highest on reptiles and amphibians and lowest on fish. Students from School A scored highest on the section concerning reptiles and amphibians and lowest on birds. At School B, graduate students scored highest on reptiles and amphibians and lowest on fish. At School C, students scored highest on reptiles and amphibians and lowest on endangered species.

Of the students from non-biology related fields, the undergraduate students as a whole scored highest on the reptiles and amphibians and lowest on endangered species (see Table 5). The graduate students scored highest on the section regarding birds and on the section on plants and lowest on the endangered species. At School A, the non-biology undergraduates scored highest on the birds and lowest on fish. There were no non-biology graduate students from School A and there were no undergraduate or graduate students from non-biology related fields from School B. At School C, the undergraduate students from non-biology fields scored highest on reptiles and amphibians and lowest on endangered species. The graduate students scored highest on mammals and lowest on endangered species.
Table 7

Comparison of Mean Number Correct Out of 5 for Each Section for Undergraduate and Graduate Students from School A, School B, and School C

<table>
<thead>
<tr>
<th></th>
<th>Birds</th>
<th>Mamm</th>
<th>Plants</th>
<th>Herps</th>
<th>Fish</th>
<th>Inverts</th>
<th>End Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sch A</td>
<td>Undg.</td>
<td>BIO</td>
<td>3.03</td>
<td>4.05</td>
<td>3.90</td>
<td>3.32</td>
<td>3.30</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td></td>
<td>3.00</td>
<td>2.21</td>
<td>2.33</td>
<td>2.21</td>
<td>1.75</td>
</tr>
<tr>
<td>Grad</td>
<td>BIO</td>
<td>3.64</td>
<td>4.29</td>
<td>4.21</td>
<td>4.39</td>
<td>3.71</td>
<td>3.86</td>
</tr>
<tr>
<td>Sch B</td>
<td>Undg.</td>
<td>BIO</td>
<td>2.62</td>
<td>2.58</td>
<td>2.71</td>
<td>3.17</td>
<td>1.92</td>
</tr>
<tr>
<td>Grad</td>
<td>BIO</td>
<td>3.25</td>
<td>3.56</td>
<td>3.75</td>
<td>4.31</td>
<td>2.88</td>
<td>3.44</td>
</tr>
<tr>
<td>Sch C</td>
<td>Undg.</td>
<td>BIO</td>
<td>2.72</td>
<td>2.78</td>
<td>2.73</td>
<td>3.27</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td></td>
<td>2.38</td>
<td>2.56</td>
<td>2.42</td>
<td>2.92</td>
<td>1.94</td>
</tr>
<tr>
<td>Grad</td>
<td>BIO</td>
<td>3.09</td>
<td>3.32</td>
<td>3.79</td>
<td>4.06</td>
<td>2.97</td>
<td>3.12</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td></td>
<td>2.71</td>
<td>3.14</td>
<td>2.71</td>
<td>2.57</td>
<td>2.21</td>
</tr>
<tr>
<td>Total</td>
<td>Undg.</td>
<td>BIO</td>
<td>2.75</td>
<td>2.94</td>
<td>2.89</td>
<td>3.27</td>
<td>2.45</td>
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<td>OTHER</td>
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<td>2.52</td>
<td>2.50</td>
<td>2.40</td>
<td>2.77</td>
<td>1.91</td>
</tr>
<tr>
<td>Grad</td>
<td>BIO</td>
<td>3.32</td>
<td>3.72</td>
<td>3.94</td>
<td>4.23</td>
<td>3.22</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>OTHER</td>
<td></td>
<td>2.71</td>
<td>3.14</td>
<td>2.71</td>
<td>2.57</td>
<td>2.21</td>
</tr>
</tbody>
</table>

Note. Mamm=mammals; Herps=reptiles and amphibians; Inverts=invertebrates; End Sp=endangered species. Green highlights=highest avg. scores; Yellow highlights=lowest avg. scores.
Comparison of Ecoliteracy of Biology Students across Universities

Since the assumptions of normality and equal variances were not met, a non-parametric Kruskal Wallis test and non-parametric t-tests were conducted to test the following hypotheses:

H3: There is no significant difference in the level of ecoliteracy of undergraduate biology students among School A, School B, and School C.

H8: There is no significant difference in the level of ecoliteracy of graduate biology students among School A, School B, and School C.

The null hypothesis H3 was rejected because results indicated that there was a significant difference in the level of ecoliteracy of undergraduate biology students across universities ($X^2=23.78$, df=2, $p<0.001$). Results of a Mann-Whitney test indicated that the mean scores for undergraduate biology and biology-related students at School A were significantly higher than those of undergraduate biology students at School B ($U=199.0$, $p<0.001$) and were significantly higher than those from undergraduate biology students at School C ($U=2513.0$, $p<0.001$). There was no significant difference in scores between School B and School C (see Figure 5).

The null hypothesis H8 was rejected because results indicated that there was a significant difference in the level of ecoliteracy of graduate biology students across universities ($X^2=13.64$, df=2, $p=0.001$). Results of a Mann-Whitney test indicated that the mean scores for graduate biology and biology-related students at School A were significantly higher than those of undergraduate biology students at School B ($U=144.0$, $p=0.049$) and were significantly higher than those from undergraduate biology students at
School C (U=218.5, p<0.001). There was no significant difference in scores between School B and School C (see Figure 5).

**Figure 5.** Average ecoliteracy test scores across Mississippi universities for biology undergraduates (blue bars) and biology graduates (green bars). Numbers in parentheses are sample sizes.

**Factors Associated with Ecoliteracy across Mississippi**

Since the assumptions of normality and equal variances were not met, non-parametric Spearman’s Rho correlations were conducted to test the following hypotheses:

H4: There is no significant correlation between the level of ecoliteracy and the number of environment-based coursework or environmental sensitivity level of undergraduate students across all universities.
H9: There is no significant correlation between the level of ecoliteracy and the number of environment-based coursework or environmental sensitivity level of graduate students across all universities.

The null hypothesis H4 was rejected because results indicated that there was a significant correlation between undergraduate ecoliteracy and both number of courses taken and environmental sensitivity level. There was a positive correlation of 0.268 (p=0.01) between level of ecoliteracy and the number of environment-based courses taken by undergraduate students. There was a positive correlation of 0.367 (p=0.01) between level of ecoliteracy and environmental sensitivity level of undergraduates.

The null hypothesis H9 was rejected because results indicated that there was a significant correlation between graduate ecoliteracy and both number of courses taken and environmental sensitivity level. There was a positive correlation of 0.641 (p=0.01) between level of ecoliteracy and number of environment-based courses taken. There was a positive correlation of 0.223 (p=0.05) between the level of ecoliteracy and the environmental sensitivity of graduate students.

A multiple linear regression was used to test the following two hypotheses:

H5: There is no significant relationship between the criterion variable of level of ecoliteracy of undergraduate students and the composite of predictor variables of age, sex, ethnicity, years lived in Mississippi, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature.

H10: There is no significant relationship between the criterion variable of level of ecoliteracy of graduate students and the composite of predictor variables of age,
sex, ethnicity, years lived in Mississippi, number of environment-related courses taken, area of residence, environmental sensitivity level, and time spent in nature.

Before the data were analyzed, all categorical variables were recoded and all interval variables were centered. Gender was recoded into “Male” as females had the highest frequency. Ethnicity was recoded into “African American” and “Other”; “Caucasian” was embedded in the constant. Residence was recoded into “Suburban” and “Urban.” “Rural”, having the highest frequency, was absorbed into the constant. Hours spent outdoors was recoded into “Few to None”, “Six to Eight”, “Eight to Eleven” and “Twelve or More.” “Three to Six” was absorbed into the constant as it had the highest frequency.

Data were analyzed to determine if the assumptions of linearity, homoscedasticity, and normality of residuals had been met. Each case was drawn independently. Results indicated that there were no issues with linearity or homoscedasticity, however, there was an issue with normality of residuals, as a histogram and test of normality indicated that the data were slightly negatively skewed and fairly leptokurtic in distribution. The studentized residuals were sorted in both ascending and descending order and results were interpreted as any value beyond +/-3 indicating an outlier. When sorted in ascending order, there was an outlier, ID #509 which had a value of -4.701. That case was removed as it appeared to be an issue with the online survey. Leverage values were sorted ascending and there were no doubling or halving effects. The DFFITS were sorted ascending and descending and there were no outliers found. Collinearity statistics indicated no issues with multicollinearity as there were no values at or approaching 0.10.
The null hypothesis H5 was rejected as results indicated that the overall model was significant (F(13,388)=14.29, p<0.001), with the model accounting for 33.1% of the variance in the level of ecoliteracy of undergraduate students (R²=0.331). Table 6 explains how much each independent variable influences the level of ecoliteracy controlling for all other variables. The constant is 20.01 and includes females, Caucasians, average years spent in Mississippi, average number of classes, being from a rural residence, two to six hours spent outdoors, and average environmental sensitivity level. Coefficients that were significant included “African American”, “Other Race”, “Classes taken”, “Spending Twelve or More Hours Outdoors”, and “ES level.”

Independent variables that had the most influence on the dependent variable were being an African American (t=-7.36, p<0.001), followed by the number of classes taken (t=4.51, p<0.001) and environmental sensitivity level (t=4.51, p<0.001). The next highest influence was spending twelve or more hours outdoors a week (t=2.6, p=0.01).

Interpretation of the unstandardized coefficients from significant variables is as follows: African Americans will score 4.42 points lower than Caucasians, controlling for all other variables. For every one course increase in the number of courses taken there will be a 0.51 point increase in knowledge score controlling for all other variables, and for every one point increase in environmental sensitivity level there will be a 0.53 point increase in ecoliteracy test score. For those undergraduate students who spend 12 or more hours outdoors each week will be a 1.89 point increase in ecoliteracy score. Other ethnicities than African American will score 2.175 points lower than Caucasians on the test of ecoliteracy level of undergraduate students.
Table 8

*Coefficients Table for Multiple Regression with Undergraduate Students*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>(Constant)</td>
<td>20.010</td>
<td>.518</td>
</tr>
<tr>
<td>Age</td>
<td>-.003</td>
<td>.030</td>
</tr>
<tr>
<td>Males</td>
<td>.013</td>
<td>.017</td>
</tr>
<tr>
<td>Black</td>
<td>-4.422</td>
<td>.601</td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>-2.175</td>
<td>.951</td>
</tr>
<tr>
<td>Years in MS</td>
<td>-.002</td>
<td>.022</td>
</tr>
<tr>
<td>Classes</td>
<td>.511</td>
<td>.113</td>
</tr>
<tr>
<td>Suburban</td>
<td>-.854</td>
<td>.547</td>
</tr>
<tr>
<td>Urban</td>
<td>-.490</td>
<td>.582</td>
</tr>
<tr>
<td>0-3 hours</td>
<td>-.172</td>
<td>.628</td>
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<tr>
<td>6-8 hours</td>
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<td>.679</td>
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<tr>
<td>8-12 hours</td>
<td>.033</td>
<td>.808</td>
</tr>
<tr>
<td>12 or more hours</td>
<td>1.892</td>
<td>.727</td>
</tr>
<tr>
<td>ES Level</td>
<td>.529</td>
<td>.117</td>
</tr>
</tbody>
</table>

*Note.* Dependent variable=undergraduate ecoliteracy score. Independent variables included in the constant were avg. age, females, Caucasians, avg. years in Mississippi, avg. classes taken, living in a rural area, 3-6 hours outdoors, and avg. ES level. p<0.01=**; p<0.05=*.

The null hypothesis H9 was rejected as results indicated that the overall model was significant (F(12, 87)=8.52, p<0.001), with the model accounting for 57.7% of the variance in the level of ecoliteracy of graduate students (R²=0.577). Table 7 explains how much each independent variable influences the level of ecoliteracy controlling for all other variables. The constant is 20.69 and includes females, Caucasians, average years spent in Mississippi, average number of classes, being from a rural residence, two to six
hours spent outdoors, and average environmental sensitivity level. Coefficients that were significant included “Other Race”, “Classes taken”, “Spending Twelve or More Hours Outdoors”, and “ES level.” Independent variables that had the most influence on the level of ecoliteracy were the number of courses taken (t=5.81, p<0.001), followed by being an ethnicity that was not African American or Caucasian (t=-4.56, p<0.001), and then environmental sensitivity level (t=3.23, p=0.002). The fourth highest influence was being a male (t=2.25, p=0.027). Interpretation of the unstandardized coefficients of significant variables is as follows: For every one course increase in the number of courses taken there will be a 0.58 point increase in knowledge score controlling for all other variables, and other ethnicities than African American will score 7.39 points lower than Caucasians, controlling for all other variables. For every one point increase in environmental sensitivity level there will be a 1.29 point increase in ecoliteracy test score of graduate students. For those graduate students who are males, there will be a 2.25 point increase in ecoliteracy score.
Table 9

*Coefficients Table for Multiple Regression with Graduate Students*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>(Constant)</td>
<td>20.691</td>
<td>1.474</td>
</tr>
<tr>
<td>Age</td>
<td>-0.011</td>
<td>0.028</td>
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<tr>
<td>Males</td>
<td>2.253</td>
<td>1.001</td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>-7.394</td>
<td>1.620</td>
</tr>
<tr>
<td>Years in MS</td>
<td>-0.023</td>
<td>0.025</td>
</tr>
<tr>
<td>Classes</td>
<td>0.577</td>
<td>0.099</td>
</tr>
<tr>
<td>Suburban</td>
<td>-0.133</td>
<td>1.455</td>
</tr>
<tr>
<td>Urban</td>
<td>-2.093</td>
<td>1.282</td>
</tr>
<tr>
<td>0-3 hours</td>
<td>-0.757</td>
<td>1.703</td>
</tr>
<tr>
<td>6-8 hours</td>
<td>0.343</td>
<td>1.262</td>
</tr>
<tr>
<td>8-12 hours</td>
<td>0.143</td>
<td>1.561</td>
</tr>
<tr>
<td>12 or more hours</td>
<td>1.080</td>
<td>1.774</td>
</tr>
<tr>
<td>ES Level</td>
<td>1.287</td>
<td>0.399</td>
</tr>
</tbody>
</table>

*Note. Dependent variable=graduate ecocitizenship score. Independent variables included in the constant were avg. age, females, Caucasians, avg. years in Mississippi, avg. classes taken, living in a rural area, 3-6 hours outdoors, and avg. ES level. p<0.01=**; p<0.05=*.*

Factors most often cited by all students as influencing their environmental sensitivity level were childhood experiences in nature, including growing up in the country or on a farm and having or raising pets or animals (n=40). The second most cited factors were a general love of the outdoors and of animals and plants (n=32). Education, including schoolwork, biology courses, and personal interests and reading were the third most cited factors influencing student environmental sensitivity (n=28). Other factors mentioned were conservation and preservation (n=23), aesthetic beauty and enjoyment of
the outdoors (n=20), climate change and habitat destruction (n=19), outdoor activities such as hunting and fishing (n=12), experience with family, relatives, or mentors (n=12), and moral and personal beliefs and values (n=10).

Factors most often mentioned by all students as influencing knowledge of local flora and fauna were courses taken as well as professors the students had (n=51). Second was overall education including degree program and fieldwork and research (n=38). The third most often mentioned factor affecting environmental knowledge was experience with family or relatives (n=22). Other factors mentioned were personal interest and reading books (n=19), general love of the outdoors and experiences in the outdoors (n=19), living in Mississippi (n=13), outdoor activities such as hunting, fishing, and hiking (n=12), and lastly childhood experiences including growing up in the country or on a farm (n=10).
CHAPTER V

SUMMARY

The Role of Ecoliteracy

Researchers have suggested that there is an increasing apathy in the study of natural history both in academic settings and in the scientific community in general (Schmidly, 2005). Natural history, the scientific study of plants and animals in their natural environments, is the cornerstone of ecological literacy. It not only instructs in the knowledge of place, but instills an emotional enthusiasm toward natural phenomena. However, the majority of studies of environmental knowledge do not directly address knowledge of natural history and local environments. Instead, the focus is on knowledge of environmental issues or problems related to human concerns, environmental concepts, or broad ecological knowledge. A more current interpretation of environmental literacy, called ecoliteracy, established the study of natural history as fundamental to environmental knowledge and seeks to determine levels of knowledge of local environments and factors associated with that knowledge (Pilgrim et al., 2007).

Considering the debate regarding the loss of natural history at universities as well as the general belief that ecoliteracy is lacking at all scholarly levels, it is surprising that there are few studies that attempt to determine knowledge of natural history of university students. The purpose of this study was to investigate the level of ecoliteracy among undergraduate and graduate students at the three largest universities in Mississippi and to determine factors affecting levels of ecoliteracy.
Ecoliteracy in Mississippi

Although studies are scant, previous research indicates that university undergraduate and graduate students across the globe have rudimentary levels of environmental knowledge (Kaplowitz & Levine, 2005; Gambro & Switzky, 1996; Tikka, 2000). Students from the top three universities in Mississippi are no exception. Neither undergraduates nor graduate students scored above a “D” average on the test of knowledge of local flora and fauna; undergraduates did not pass the test scoring an average of 52% correct, while graduates ranked marginally better with 62% correct. These totals were similar to the scores of Michigan State University students who scored only 66% on a state test of environmental knowledge (Kaplowitz & Levine, 2005).

Comparisons of ecoliteracy levels of three Mississippi universities revealed similarities and differences among the schools. Undergraduate student scores were significantly similar across School A, School B, and School C. However, graduate students scores were significantly higher at School A than scores of School B and School C graduates. School B graduate scores were significantly higher than School C. This may have been due, in part, to sampling sizes. Neither School A nor School B had any graduate students from majors outside of biology-related majors, so the scores would be expected to be higher.

Previous studies in ecoliteracy have suggested that students at all levels have rudimentary knowledge of local arthropods, birds, mammals, and plants (Bebbington, 2005; Evans et al., 2006; Huxham et al., 2006). Huxham et al. (2006) found that student knowledge of mammals was significantly better than that of arthropods and birds. It seemed, in the present study, that both undergraduate and graduate students were most
proficient in their knowledge of reptiles and amphibians. Undergraduates and graduates from all schools scored highest on this section. This finding is not surprising from Mississippi students who are taught from childhood to stay away from the several venomous snakes in the area and who see and experience turtles, frogs and toads throughout their lives. There is, of course, the possibility that the herpetology section was not as challenging as the other sections, but the professional reviewers of this research did not think that was the case. The researchers could not find any previous studies that either utilized reptiles or amphibians in the study or that reported greater knowledge of reptiles or amphibians.

Overall, undergraduate students were least knowledgeable of the endangered species of Mississippi. Again, although it is a possibility, it is not believed that the endangered species section contained comparatively more challenging questions than any other sections. This finding is especially troubling as Mississippi universities are leaders in the study of endangered species in the state and indicates that endangered species research and information is not being stressed or disseminated to undergraduate students. In contrast, graduate students scored, overall, lowest on the section concerning fish; an interesting contradiction considering the large number of wildlife and fisheries students.

Undergraduate students from School A, having the greatest number of wildlife and fisheries students, were most proficient in knowledge of mammals and least proficient with invertebrates. Strangely, graduate students from School A, composed entirely of wildlife and fisheries students, were least proficient with birds, and were the only group to score lowest on birds. Unfortunately, although School C has a high number
of biology faculty devoted to the study of endangered species in Mississippi, all students from School C were least knowledgeable of endangered species.

Ecoliteracy across Academic Fields

Previous studies indicated that there were distinctions in the level of environmental knowledge across academic fields. Tikka et al. (2000) found that biology students scored the highest on tests of knowledge of nature and the environment, followed by students from the Institute of Forestry and students majoring in history. They determined that students from the Commercial College, the Pre-school Teacher Training Institute and the College of Health Care were the least proficient in nature knowledge. In contrast, Kaplowitz and Levine (2005) discovered that the highest scoring colleges at Michigan State University were Osteopathic Medicine, Human Medicine, Agricultural and Natural Resources, Veterinary Medicine, and Natural Science. Those scoring lowest were Nursing, Business, and Education. In the present study, students were separated by academic level and the researchers found that undergraduate and graduate students from wildlife and fisheries outperformed those from biology and non-biology related majors. Biology majors had a higher level of ecoliteracy than those of non-biology related majors.

Biology students from School A, comprised mostly of wildlife and fisheries and forestry majors, had higher levels of ecoliteracy than School B and School C, whereas there was no difference in the ecoliteracy of biology students from School B and School C. These findings are not surprising as wildlife and fisheries majors take mostly organismal classes to earn the degree, while biology majors are required to take many micro and cell biology courses as well as physics and chemistry, and not as many
organismal courses. Additionally, biology majors include those with no background in environment-based coursework.

Because of the larger sample sizes and connections with the university, the researchers completed additional testing on the sample from School C. Both undergraduate and graduate biology students were more ecoliterate than those students from non-biology majors. Again, the findings are to be expected as biology majors should be taking at least minimal environment-based coursework compared to non-majors, or may have a greater interest in living organisms. It is encouraging that biology majors are outperforming non-biology majors indicating that coursework may be a factor contributing to the development of ecoliteracy.

The majority of undergraduate and graduate students of biology as well as other majors were most proficient with reptiles and amphibians. According to previous research, we would expect for students to have a greater knowledge of mammals (Huxham et al., 2006), however, as previously mentioned, students in Mississippi may have a stronger knowledge of reptiles and amphibians due to common experiences with snakes and other reptiles and amphibians. There were three exceptions; undergraduate biology students from School A and School C graduate students from majors other than biology scored highest on mammals, and undergraduates from other majors at School A were most proficient at birds. This finding is especially interesting because biology graduate students at School A, mostly wildlife and fisheries students, were least proficient with birds.

Both undergraduate and graduate biology and non-biology majors struggled with fish and endangered species. This finding is disturbing because of the role of Mississippi
universities in researching and conserving endangered species. At School C, many of the biological laboratories study endangered species of Mississippi and several times each year give seminars and presentations to students. It is alarming that biology undergraduates at School C and elsewhere are not knowledgeable of endangered species in Mississippi. Additionally, we would have expected biology graduate students from School C to have scored higher on the endangered species section. School A graduate students, for example, scored an average of 4.36 points on that section, while School C graduate students scored an average of 3.18 points.

Factors Associated with Ecoliteracy

Factors having the strongest effect on ecoliteracy for both undergraduates and graduates were ethnicity, the number of environment-based courses taken, and environmental sensitivity level. Surprisingly, as this factor was not found in previous literature in ecoliteracy, being an African American had the greatest effect on level of ecoliteracy of undergraduates. It was predicted that African Americans would score over four points lower on the test of ecoliteracy. African Americans were absent from the graduate sample, however, ethnicity did have a strong effect on graduate student ecoliteracy. It was predicted that being a race other than Caucasian or African American, e.g. Asian, Hispanic, and other ethnicities, resulted in an over seven point decrease in ecoliteracy score. Future research should address these findings to determine how educators at all levels can reconnect students of differing ethnicities to the natural world.
Ecoliteracy and Educational Coursework

Previous research has indicated that students majoring in the natural sciences, such as biology, forestry, agriculture, and natural resources have higher levels of environmental knowledge (Kaplowitz & Levine, 2005; Tikka et al., 2000). However, no studies have investigated whether or not this is due to a general affinity of these students toward nature or if it is due to courses taken and educational experiences of these majors. Researchers from the present study found that there was a positive relationship between the number of environment-based courses taken and level of ecoliteracy. In fact, for undergraduate students, the number of courses taken had the strongest effect on ecoliteracy levels after ethnicity, and coursework had the greatest impact on graduate ecoliteracy. Students from School A had the highest average number of courses taken, and had the highest overall levels of ecoliteracy. Optimistically, courses in natural history and professors who teach them are fostering ecoliteracy in their students. Unfortunately, if there is a decline in the presence of natural history in universities, we are contributing to the lack of ecoliteracy, simply by turning our attentions elsewhere.

Students at all levels recognize the importance of their educational coursework to their understanding of natural history. Students with the highest levels of ecoliteracy most often mentioned courses taken as well as professors the students had as influencing knowledge of local flora and fauna. Second most mentioned were experiences in the overall degree program, including fieldwork and research. These findings conflict with ecoliteracy research conducted by Pilgrim et al. (2007) who found that residents in the UK having the highest levels of ecoliteracy gained that knowledge from parents, relatives
or friends instead of schooling or television. In the present study, experiences with family or relatives was the third most often cited factor associated higher levels of ecoliteracy.

_Ecoliteracy and Environmental Sensitivity_

Environmental sensitivity, loosely defined as empathy for nature or the environment in which one lives, is considered a prerequisite to responsible environmental behavior and has been found to be a correlate with positive environmental attitudes and knowledge of the environment (Acury, 1990; Chawla, 1998; Hungerford & Volk, 1990). Studies have indicated that one of the main factors contributing to environmental sensitivity is direct experience in the outdoors at a young age. Those people who were rated as having high environmental sensitivity often had long-term experiences, such as hunting, fishing, camping, or exploring, in familiar natural areas (Chawla, 1998; Hungerford & Volk, 1990; Kals, Schumacher, & Montada, 1999; Wilke, 1993).

However, Kals et al. (2009) found that the most powerful predictor of environmental sensitivity was present time spent in nature, followed by past time spent in nature. Additionally, Sivek (2002) found that high-school students cited time spent outdoors as most important to environmental sensitivity.

The self-reported factor affecting environmental sensitivity most often mentioned by undergraduate and graduate students was childhood experiences in nature, including growing up in the country or on a farm and having or raising pets or animals. These findings are similar to those of Palmer and Suggate (1996) who suggested that childhood experiences in nature and the countryside were most influential in developing environmental sensitivity. In the previous study, however, the researchers found that over 60% of educators mentioned education at the secondary and university levels as
important to their environmental sensitivity. Education, including previous schooling and university coursework was found to be the third most important factor in promoting environmental sensitivity in undergraduate and graduate students in Mississippi. In contrast to several ES studies in the past, the present researchers determined that experience with family, relatives, and mentors did not play as large a role in developing environmental sensitivity (Chawla, 1998; Sivek, 2002). However, this was found to be an important factor in the expansion of knowledge of local flora and fauna.

The current study found that environmental sensitivity was both positively related to ecoliteracy and is a strong predictor of ecoliteracy. For example, graduate students were predicted to score 1.2 points higher on the ecoliteracy test as their environmental sensitivity levels increased. Students from School A had the highest mean level of environmental sensitivity and had the highest overall level of ecoliteracy at all educational levels. This study is the first to discover that environmental sensitivity, at least self-reported ES, is a predictor of ecoliteracy.

_Ecoliteracy and Time Spent Outdoors and Residence Area_

Time spent in nature and areas of residence have been found to be important not only to fostering environmental sensitivity, but also to developing ecoliteracy (Kals et al., 2009; Pilgrim et al., 2007; Sivek, 2002). Researchers in the current study found that undergraduate students who spent 12 or more hours a week outdoors had higher levels of ecoliteracy. However, time spent outdoors was not a significant predictor of ecoliteracy in graduate students. On average, School A students spent more time outdoors than students from School B or School C and more School A students lived in rural areas than students from the other schools. Since School A had the highest levels of ecoliteracy,
these findings support those of Pilgrim et al. (2007) who found that the most important factors affecting ecoliteracy were time spent in the countryside and being from a rural area. Although it was mentioned, present time spent outdoors was not one of the most often self-reported factors affecting either environmental sensitivity or knowledge of local flora and fauna of Mississippi university students.

**Ecoliteracy and Gender and Age**

Previous research has shown that gender has an effect on ecoliteracy and environmental knowledge. Tikka et al. (2000) found that male college students had higher levels of environmental knowledge than females. Pilgrim et al. (2007) determined that gender had no impact on ecoliteracy in the UK, but males had higher levels of ecoliteracy in Indonesian and India. Huxham et al. (2006) found that boys had greater wildlife knowledge than girls. In the present study, gender was found to have an effect on ecoliteracy in the graduate students only. Graduate students who were males would be predicted to score over two points higher than females on the test of ecoliteracy.

Age has been shown to be an important factor affecting ecoliteracy; older, more experienced participants generally have higher levels of ecoliteracy (Balmford et al., 2002; Huxham et al., 2006; Nyhus, et al., 2003; Tikka et al., 2000). The current research suggests that age is not an important factor in determining level of ecoliteracy of students in universities in Mississippi. This is an important finding because it supports the opposite of what we might predict that the longer one lives in an area the better he or she knows that area. This has been suggested in the literature on Traditional Ecological Knowledge; connection and knowledge of an area is associated with the amount of time lived there (Nyhus et. al., 2003). It seems realistic that older students and those who have
spent more time in Mississippi would have more knowledge of local flora and fauna. This was not the case in this study and strengthens the argument that coursework and education along with time spent in nature are important to the development of ecoliteracy.

The Importance of Direct Experience with Nature

Despite strong efforts toward the inclusion of environmental education in schools, there is a growing concern that children, as well as adults, are becoming even more disconnected and estranged from the natural world. Exploration and investigation of natural phenomenon have been eclipsed by sterile playgrounds and indoor pursuits with video games, television, and computers (Louv, 2005; Wivaag, 1994). Recent research has shown that children spend less time outdoors than their parents did (Clements, 2004) and have less free time and spend more of their time on structured activities (Hofferth & Sandberg, 2001). In addition, many biologists, conservationists, and educators have suggested that there is decreasing interest in the study of natural history at academic institutions and in the scientific community in general (Futuyma, 1998; Grant, 2000; Noss, 1996; Schmidly, 2005; Wilcove & Eisner, 2000; but see Arnold, 2003). Natural history courses, such as those concerning local flora and fauna, are declining (Dayton, 2003; Futuyma, 1998; Noss, 1996; Schmidly, 2005). Natural history courses often include a “field” component, allowing the students and professors time to connect with their natural surroundings (Wilcove & Eisner, 2000). The importance of this direct experience with nature is emphasized by Pyle’s (2001) concept of “extinction of experience”; students who spend less time in natural environments recognize less and are less likely to want to protect the species with which they are unfamiliar. At a time when
loss of biodiversity is rampant, it is of utmost importance that scientists as well as the general public are familiar with local environments and have an empathy and support for them.

Results of this study, along with previous research, support the concept of direct experience with nature to prevent the “extinction of experience” expounded by Pyle (2001). Research suggests that ecoliteracy as well as environmental sensitivity, a factor contributing to ecoliteracy, is associated with and can be fostered by individual experience with nature and time spent in the outdoors (Chawla, 1998; Kals et al., 2009; Pilgrim et al., 2007; Sivek, 2002; Tikka et al., 2000). The study of natural history has in the past and can in the future provide that experience.

How can we return natural history to its proper place in universities? Requiring curriculum for biology majors that includes environment-based courses with field components would be a first step. Wivaag so keenly stated that “living organisms and the outdoors are the natural provenance of biology” (1994, P.131); we should expect our biology students, regardless of emphasis, to be knowledgeable of local flora and fauna. Krupa (2000) suggests including outdoor laboratory exercises on campus, taking classes to biological stations, reinstating day and weekend field trips, and instilling in students the naturalist philosophy of discovery, awareness, and spontaneity. It can be supported by evidence from this and previous studies that universities should provide coursework and outdoor opportunities promoting ecoliteracy across majors and departments. The Lake Thoreau Environmental Center at School C, for example, is an excellent resource for university professors and local teachers to immerse students in the natural world.

Schools, universities, government agencies, and research foundations must review current
methodology and agree upon an approach of holistic inclusion of natural history at all
levels (Greene, 2005; Herman, 2002; Wilcove & Eisner, 2000). Environmental issues we
face now and in the future cannot be solved by scientists alone; it will take an
unprecedented call to action of all people of the Earth. It is imperative that we are
knowledgeable and ready to act. It is time for university departments, professional
societies, government and private agencies, and citizens of the world to join together and
support the second coming of natural history.
Dear Student,

To fulfill, in part, the requirements for the degree of doctor of philosophy we are conducting a research dissertation on the ecoliteracy of undergraduate and graduate students enrolled at School A, School B, and School C. The purpose of this study is to determine how much students know about Mississippi flora, fauna, ecology, and the local environment. We are requesting that you please complete the attached test. It will take approximately fifteen to twenty minutes to complete.

Participation in this study is completely voluntary and all participants will remain anonymous. Please do not put your name or any other identifying information on the questionnaire. You may discontinue participation at any time without penalty or prejudice. Any identifying information obtained during the course of this study will remain completely confidential. By returning this questionnaire, participants are giving their consent for this anonymous and confidential data to be used for the purposes described above. All questionnaires will be maintained by the researchers in a secure location. Data will be collected, analyzed and will be reported in the dissertation. Questionnaires will be destroyed when data analysis has been completed.

This research is being conducted under the supervision of Sherry S. Herron, Ph.D. This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, School C, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820. All interested parties may contact the following people with any questions and/or comments in regard to this project:

Sarah Wheeless  
(601) 266-4739  
sarahwheeless@yahoo.com

Sherry Herron, Ph.D.  
(601) 266-4739  
sherry.herron@usm.edu

Thank you,

Sarah Wheeless and Sherry Herron, Ph.D.
Knowledge of Mississippi Flora and Fauna

Please place a (√) next to the answer that best describes you:

What University do you attend?  ____Sch A  ____Sch B  ____Sch C

Gender:  ____Male  ____Female

Classification:  ____Freshman  ____Sophomore  ____Junior  ____Senior  ____Masters  ____PhD

Ethnicity:  ____African American/Black  ____Asian  ____Caucasian/White  ____Hispanic  ____Other

What is your academic major?  ____Biology  ____Wildlife and Fisheries  ____English  ____Other (please list):____

In what type of area do you live?  ____country (rural)  ____city (urban)  ____suburban (intermediate)

How many hours do you spend outdoors each week?
____0-2 hours  ____3-5 hours  ____6-8 hours  ____9-11 hours  ____more than 12 hours

What is your age?  ____________ years.

How many years have you lived in Mississippi?  ____________ years.

Please answer the following questions based on the definition of Environmental Sensitivity given below:

Definition: Environmental Sensitivity = Having empathy for or relating to other living things or nature in general.

My level of environmental sensitivity is (circle one number):

<table>
<thead>
<tr>
<th>Very Low</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Very High</th>
</tr>
</thead>
</table>
What one or two factor(s) contributed most to your Environmental Sensitivity level?
________________________________________________________________________
________________________________________________________________________
What one or two factor(s) contributed most to your knowledge of Mississippi flora and fauna?
________________________________________________________________________
________________________________________________________________________
Please place a (√) next to all of the following classes that you have taken:

- Animal Behavior
- Avian Biology
- Avian Ecology
- Aquatic Botany
- Aquatic and Marsh Plants
- Behavioral Ecology
- Biology of Fishes
- Biology of Vertebrates
- Conservation Biology
- Conservation and Restoration

Ecology
- Dendrology
- Ecology
- Ecology and the Environment
- Economic Botany
- Ecosystem Ecology
- Entomology
- Environmental Biology
- Environmental Quality
- Field Biology
- Forest Description and Analysis
- Freshwater Biology
- Herpetology
- Ichthyology
- Introduction to Forest Communities
- Invertebrate Zoology
- Limnology
- Local Flora
- Mammalogy
- Marine Biology
- Marine Ecology
- Mycology
- Natural Resource Management
- Plant Diversity
- Plant Ecology
- Population and Community Ecology
- Principles of Silviculture
- Principles of Wildlife Conservation and Management
- Stream Ecology
- Upland Avian Ecology and Management
- Waterfowl Ecology and Management
- Wetlands Ecology
- Wildlife Techniques
Knowledge of Mississippi Flora and Fauna

Birds

1) What is the name of this state bird of Mississippi?

- Northern Cardinal
- Brown Pelican
- Northern Mockingbird
- Eastern Bluebird

2) Which of these raptors feeds primarily on fish?

- Red-tail Hawk
- Osprey
- Cooper’s Hawk
- Mississippi Kite

3) Where would you most likely encounter this bird?

- In the city
- Upland forest
- Bottomland forest
- Marsh
4) Which bird lives in Mississippi during the winter but not during the summer?
   a. White-throated Sparrow
   b. Ruby-throated Hummingbird
   c. Carolina Chickadee
   d. Eastern Towhee

5) What bird made this sack-like nest?
   a. Carolina Wren
   b. Eastern Bluebird
   c. American Robin
   d. Orchard Oriole

Mammals

1) What is the name of this Mississippi mammal?
   a. Armadillo
   b. Virginia Opossum
   c. Raccoon
   d. Long-tailed Weasel
2) Which of these mammals is an omnivore?
   a. Black Bear
   b. Bobcat
   c. Beaver
   d. Whitetail Deer

3) Which of these mammals is not found in Mississippi?
   a. Fox Squirrel
   b. Mink
   c. Eastern Cottontail
   d. Gray Wolf

4) What mammal made this track?
   ![Track Image]
   a. Whitetail Deer
   b. Bobcat
   c. Raccoon
   d. Coyote

5) What mammal often leaves its scat at the base of a large tree or on a fallen log?
   a. Raccoon
   b. Coyote
   c. Muskrat
   d. Armadillo
Plants/Trees

1) What is the name of this state tree of Mississippi?

   a.  Southern Live Oak
   b.  Southern Magnolia
   c.  Longleaf Pine
   d.  Red Maple

2) Which of these trees does not lose its leaves in the winter?

   a.  American Holly
   b.  White Oak
   c.  Shagbark Hickory
   d.  Black Cherry

3) Which of these trees would you most likely find on the bank of a stream or river?

   a.  Longleaf Pine
b. Southern Red Oak

c. Mockernut Hickory

d. Eastern Sycamore

4) What is the name of this vine which has fruits that are eaten by a variety of animals?

a. Japanese Honeysuckle
b. Poison Ivy
c. Virginia Creeper
d. Carolina Jasmine

5) Which of these plants is not an invasive species in Mississippi?

a. Cogon Grass (*Imperata cylindrica*)
b. Tallow Tree (*Sapium sebiferum*)
c. Mayapple (*Podophyllum peltatum*)
d. Water Hyacinth (*Eichhornia crassipes*)

**Reptiles and Amphibians**

1) What is Mississippi’s largest frog?

a. American Toad
b. Bear Frog
c. Bullfrog
d. Spring Peeper

2) Of the 41 species of snakes found in Mississippi, how many are venomous?

a. 0
b. 6
c. 13
d. 20

3) Which of these is considered a terrestrial turtle?

a. Eastern Box Turtle
b. Eastern Mud Turtle
c. Mississippi Map Turtle
d. Red-eared Slider
4) Which one of these animals is not a lizard?

a. 

b. 

c. 

d. 

5) Which of these snakes is known to “play dead” when threatened?

a. Broad-banded Watersnake
b. Eastern Coachwhip
c. Black Racer
d. Southern Hognose
Fishes
1) Which species of Mississippi fish, pictured below, is primarily a bottom feeder?

![Fish Image]

a. White Perch  
b. Bullhead  
c. Striped Bass  
d. Bream

2) Which of these fishes is not considered a salt water fish?

a. Atlantic Croaker  
b. Southern Flounder  
c. Bigmouth Buffalo  
d. Red Snapper

3) What fish species is shown in this picture?

![Fish Image]

a. Black Crappie  
b. Striped Bass  
c. Spotted Gar  
d. Bluegill

4) Which of these is the migratory fish species?

a. Flathead Catfish
b. Alligator Gar

c. Gulf Sturgeon

d. Spotted Sunfish

5) Which of these fish spawn earliest in the year?

a. White Perch

b. Channel Catfish

c. Largemouth Bass

d. Longear Sunfish

**Spiders/Insects/Invertebrates**

1) Circle a carnivorous insect found in Mississippi.

a. Luna Moth

b. Carpenter Bee

c. Praying Mantis

d. Leafhopper

2) In what habitat would you most likely find a Mayfly larva?

a. Freshwater stream

b. Gulf of Mexico

c. Pine Savannah

d. Hardwood Forest

3) What animal made this burrow?

a. Dirt Dobber

b. Crayfish
c. Fiddler Crab

d. Dung Beetle

4) Which of these spiders could cause **major** tissue degeneration if it were to “bite” a human?

a. 

b. 

c. 
5) Which of these butterflies found in Mississippi has no orange coloration on its wings?
   a. Monarch
   b. Cloudless Sulfur
   c. Gulf Fritillary
   d. Spicebush Swallowtail

**Endangered Species**

1) What is the most important habitat type for Black Bears in Mississippi?
   a. Upland Pine Savannah
   b. Bottomland Hardwood Forest
   c. Freshwater Marsh
   d. Agricultural Fields

2) Which animal is thought to be extinct in Mississippi?
   a. Gray Fox
   b. Pileated Woodpecker
   c. Gulf Sturgeon
   d. Ivory-billed Woodpecker

3) Which of these Mississippi animals is no longer an endangered species?
   a. Louisiana Black Bear
   b. Mississippi Sandhill Crane
   c. American Alligator
d. Gopher Tortoise

4) In what habitat would you most likely find a Gopher Tortoise?
   a. Bottomland Hardwood Forest
   b. Upland Pine Savannah
   c. Saltwater Marsh
   d. Riparian

5) Which group of animals has the greatest number of endangered species in Mississippi?
   a. Mussels
   b. Fishes
   c. Turtles
   d. Birds
APPENDIX B

USM INSTITUTIONAL REVIEW BOARD DISSERTATION APPROVAL FORMS

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board
118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 21, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherene to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the “Adverse Effect Report Form”.
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 27110503
PROJECT TITLE: Do Mississippi Science Teachers Know Their Nature?
PROPOSED PROJECT DATES: 10/01/07 to 12/10/07
PROJECT TYPE: New Project
PRINCIPAL INVESTIGATORS: Sarah Wheless
COLLEGE/DIVISION: College of Science & Technology
DEPARTMENT: Center for Science and Math Education
FUNDING AGENCY: N/A
HSPRC COMMITTEE ACTION: Exempt Approval
PERIOD OF APPROVAL: 11/08/07 to 11/07/08

Lawrence A. Hosman, Ph.D.
HSPRC Chair

Date: 11-13-07
THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board
118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
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- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 29101906
PROJECT TITLE: The Natural Provenance: Ecoliteracy in Higher Education in Mississippi
PROPOSED PROJECT DATES: 10/15/09 to 10/15/10
PROJECT TYPE: Dissertation
PRINCIPAL INVESTIGATORS: Sarah Wheless
COLLEGE/DIVISION: College of Science & Technology
DEPARTMENT: Center for Science & Math Education
FUNDING AGENCY: N/A
HSPRC COMMITTEE ACTION: Expedited Review Approval
PERIOD OF APPROVAL: 10/22/09 to 10/21/10

[Signature]
Lawrence A. Hosman, Ph.D.
HSPRC Chair

[Signature]
Date
REFERENCES


